INTERNATIONAL

MARINE ENGINEERING

Published Monthly by ALDRICH PUBLISHING CO.

461 EIGHTH AVENUE, NEW YORK

H. L. Aldrich, President and Treasurer
Assoc. Member of Council, Soc. N. A. and M. E.

George Slate, Vice-President
E. L. Sumner, Secretary

8 BOUVERIE ST., LONDON, E. C.

E. J. P. Benn, Director and Publisher
Associate Inst. N. A.

Edited by H. H. Brown, A. M. Inst. N. A.
Member Soc. N. A. and M. E.

Vol. XXIII APRIL, 1918 No. 4

Buy Liberty Bonds

NO delusion exists as to why we are fighting Germany. We must win the war quickly, if possible. We must carry it on for years, if necessary. Let the cost be what it may, our sons and brothers are eagerly going to the front as quickly as we can send them over, and support them. To do this, however, calls not only for an honest day's work from every able-bodied man in the country every working day in the year but it also calls for money. Two huge loans have already been generously over-subscribed as evidence that our hearts and souls are in the work, but we have only begun to prepare to do our share. A third loan is now called for. This is your opportunity. Remember that there is no surer way of betraying our men in France to the enemy than by stopping the industrial home work. Invest your all and speed the victory. Buy Liberty bonds!

Progress in Shipbuilding

ALTHOUGH this is our annual shipbuilding number, war conditions make it inadvisable to publish a complete record of the output of American shipyards during the past year and the amount of work on hand at the beginning of the current year, as has been our custom in the past. Figures published by the Shipping Board, however, give some idea of the magnitude of the Government shipbuilding programme and the progress which has so far been made towards its completion.

On March 1 the total amount of steel ship construction in hand was 8,205,708 deadweight tons, made up of 5,160,300 deadweight tons under contract for the Emergency Fleet Corporation and 3,045,408 deadweight tons of requisitioned vessels. The work which has so far been completed on this tonnage is equivalent to about 28 percent of the programme. Since the Shipping Board began its shipbuilding operations, 188 vessels have been launched, of which 103 have been completed and put into service. The launchings were divided between 165 requisitioned vessels and 23 vessels which were built on contract for the Shipping Board in yards that were especially constructed for the purpose, or which had only just been put into operation. Eleven of the vessels launched were of wood, the remainder being of steel. Of the steel ships under contract and under requisition, 655,456 tons deadweight, or approximately 8 percent of the total, were actually completed and in service on March 1, 1918. This exceeds the total output of American shipyards in 1916 by approximately 50 percent. Put in another way, nearly as much tonnage has been constructed in American shipyards in the first quarter of 1918 as by all the other maritime nations of the world.

The magnitude of the task which the Shipping Board has undertaken is shown not only by the total amount of tonnage contracted for or requisitioned but also by the tremendous expansion of shipbuilding facilities in the past twelve months. When the Government programme for building merchant ships was started there was no shipyard in the country where an order could be placed. Seventy percent of the capacity of the established yards was engaged in naval work and the remainder was filled to capacity for several years with orders from private shipowners and for foreign account. Under these conditions, it was necessary not only to build new shipyards but also to get experienced shipbuilders to take charge of them and to train inexperienced men to build the ships.

Eight months ago there were only 37 shipyards in the United States equipped for building steel vessels. At that time these yards had 162 shipways: at present they have 195 shipways. Thirty new steel shipyards with 203 shipways are now being erected, so that the Emergency Fleet Corporation will have a total of 398 shipways for building steel vessels. Thirty-five of these yards, with 258 ways, are on the Atlantic and Gulf coasts; 19 yards, with 66 ways, on the Pacific coast, and 13 yards, with 74 ways, on the Great Lakes.

For building wooden vessels, there were in existence 8 months ago 24 yards with 73 shipways. The Shipping Board now has 81 wooden shipbuilding yards with 332 ways completed or nearing completion. Assuming that two wooden ships will be built on each way in a year, the annual output of wooden vessels should reach 2,300,000 deadweight tons.

Recapitulating the above figures, the capacity of American shipyards has increased in less than a year from a total of 235 shipways, made up of 162 for steel vessels and 73 for wood vessels, to a total of 730 shipways, 398 of which are for steel vessels and 332 for wooden vessels. With 730 shipways, the United States will have 521 more berths for building ships than has England at the present time.

"Fail With Ships and We Fail Utterly"

WITH the above utterance by the chairman of the Shipping Board challenging the country, can any one of the thousands of men employed in the shipyards of America falter for an instant in the faithful performance of his duties, however humble they may be?

We are fighting for liberty and freedom. Stern realities cannot be evaded. The submarine has not been vanquished from the high seas. Its menace has been slightly lessened, but since the war began nearly 12,000,000 tons of shipping have been sunk and less than 7,000,000 tons have been built. Can these facts be faced by shipyard workers without an instantaneous response to our country's needs?

Upon their efforts, says Chairman Hurley, rests the whole burden of making American victory possible. Delays mean defeat. An honest day's work every working day in the year is required of every man employed in the

shipyards of America. Every hour is priceless. Speed up the ships!

The Government Assembling Yards

BY far the most spectacular feature of the Government shipbuilding programme is the extent to which the new method of building ships, popularly known as "fabricating" ships, has been adopted. So great a saving in time of production will result from this method, it is estimated, that the three great assembling yards which the Government has built—one at Hog Island, Philadelphia, with 50 ways; one at Newark, N. J., with 28 ways, and one at Bristol, Pa., with 12 ways—will, when in full operation, be able to produce in a single year more ships than England, the greatest maritime nation in the world, has ever been able to turn out in the same length of time.

These three yards are now so far advanced that shipbuilding operations have already begun; 13 keels have been laid at the Newark plant, 4 at Bristol and 2 at Hog Island. In all the yards the same general principles govern the operation, but, as each yard is building a different size vessel, the arrangement and equipment differ materially. We regret that the policy of the Emergency Fleet Corporation will not permit us to publish complete details of the construction and operation of these yards, but brief descriptions authorized by the Shipping Board will be found in the following pages.

In design, the fabricated ships do not differ materially from ordinary cargo vessels, except that they are simplified to include as much straight line and flat work as possible, and also to reduce to a minimum the number of operations that will be required in fabricating and erecting the separate parts of the hull. The general plans and a detailed description of the 5,000-ton vessel which is being built by the Submarine Boat Corporation at the Newark Bay plant (published here for the first time) will also be found elsewhere in this issue.

Fair Play For Our Flag!

IN the article published on another page of this issue—"American Classification for American Ships"—facts are set forth that demand frank attention of the officials of the United States Shipping Board, in Washington. Marine Engineering pointedly referred in the December issue to the unwisdom of allowing a distinctively foreign concern to supervise the construction of American ships building for the American Government. Mr. Marvin, in his article in the present issue, recalls certain facts in our maritime history which ought to prompt the Shipping Board to execute a square "about face" and eliminate the British Lloyd's at once and forever from all authority over American ship construction.

Most of our enormous military expenditures now being made to beat Germany and save our Allies will leave no trace after the war has ended. But our vast new merchant fleet will remain, and with prudent direction may prove a highly valuable asset to the American people and their Government. A great merchant marine, however, is more than a mere matter of ships; these ships must have a fair and dependable classification in order to be able to command all-requisite insurance for themselves and for their cargoes. What suicidal madness is it that would leave this classification, and thereby this insurance, to the whims of an absolutely alien society created and maintained for the express purpose of promoting the trade and navigation of the nation that traditionally has been, and certainly will be, our greatest and most formidable antagonist?

The British Lloyd's Register and Lloyd's underwriters have a long record of savage discrimination against American shipbuilders and shipowners which cannot be recalled at this day without an indignation that well nigh chokes utterance. What they have done once they will most assuredly do again if we ever give them an opportunity. There might be some excuse for allowing Lloyd's to finish its work upon those steamers now building in American yards that were originally ordered for the British government and now have very properly been commandeered by our own authorities, but right at this point toleration must cease. No new contracts must be made, and Lloyd's surveyors must be left to depart as quickly as possible for their rightful place on the other side of the Atlantic Ocean.

We can build our own ships—we can design them, and we can survey and classify them through our own American Bureau of Shipping, created for the purpose, which it can now abundantly fulfill, of performing the same service for the United States which the British Lloyd's for so many years has been performing for the British Empire. We bear our British kinsmen no ill will, but they are one people and we are another. We have a government of our own; we have a navy of our own; we have —or we are going to have—a merchant marine of our own, and in order to have it and to keep it we must have a distinctively American inspection, survey and classification service as the vital prerequisite of an American system of marine insurance.

By no single step can the Shipping Board strengthen itself more decisively with the nation and clinch the future success of the American merchant marine which it is building than by causing it to be known at once that just as fast as the ships which the British Lloyd's is now supervising are completed the services of Lloyd's will be dispensed with and the inspection, survey and classification of all the other vessels being constructed for the American people in American yards with American money will be reserved to loyal and competent American hands.

This prudent, patriotic policy inflexibly maintained will assure our country of a classification society greater and better than Lloyd's when the work is completed, and of American underwriting resources sufficient, when the war is ended, to give all our new American ships fair play for cargoes and insurance in all the ports and all the commerce of the world.

Short Cuts and Innovations

NEVER before has there been a time when short cuts and new methods of speeding up production in shipbuilding were more eagerly sought. New ideas and schemes have been offered by the hundreds, but few give tangible evidence of practical value. With the successful launching of the 5,000-ton concrete ship *Faith* last month, a new impetus is given to the development of concrete shipbuilding, an innovation to which the Shipping Board is already committed. Similarly, a corporation has been formed to build an experimental 10,000-ton cast steel ship, another project which may be sound in theory but regarding which practical experience and tests are lacking. The electric welding of steel plates is also being tried out at some of the shipyards with a view to its utilization in the construction of steel ships. If successful, these innovations in shipbuilding will offer numerous advantages in the race for more rapid production of tonnage. If they fail, the money spent in investigation and experiment will mean only a trifling loss, and the sooner the truth is known, the better.

A special message from the CHAIRMAN OF THE SHIPPING BOARD

To the Shipbuilders of America!

TO you falls the task the successful accomplishment of which will determine the result of the war. Upon you rests the whole burden of making American victory possible. Patriotism demands your greatest effort. Can you give to your country the best that is in you in this hour of danger to the civilized world?

Our factories are working overtime to provide the materials and supplies needed by our army abroad and our Allies; American farms are raising the food that must be sent across the seas if England and France are to survive. Our railroads can carry the war material and the food to port, but without ships their efforts are in vain. Food will spoil on the piers and be wasted; Pershing's army in France will be a burden rather than an agency of delivery for the suffering people.

Increase the world's tonnage and American supplies will flow steadily and in ever-increasing volume across the Atlantic. I believe that American mechanics can do this great thing and do it quickly and well. Once they realize the great need for ships, nothing can prevent successful accomplishment of their task, but it will require an honest day's work every working day by every man employed in the shipyards of America. It will require constant vigilance to detect and expose the shirkers; it will demand a spirit of confidence and a will to win.

Give us all that and the submarine will be vanquished from the high seas and the people of the world assured of freedom.

Edward N. Hurley

The Organization of the Emergency Fleet Corporation

by

WALDON FAWCETT

FORMIDABLE as are the problems of practical ship construction that must needs be solved in hot haste for the realization of the war-inspired dream of an American merchant marine, they are all but paralleled in responsibility by the problems of organization. To create within the span of a single year the complete administrative machinery for the greatest shipbuilding enterprise ever undertaken under one management has been in itself a herculean task, but to grasp the full significance of this achievement it must be borne in mind that this huge executive staff has had no opportunity to work out its own salvation with singleness of purpose, so to speak. Even as the new organization has been "finding itself," it has been necessary, again and again, to turn aside from the problems of organization to concentrate on constructive work in the field—the field meaning in this instance our entire far-flung coast line.

Mushroom Growth of the Corporation

The mushroom growth of the Emergency Fleet Corporation is not, perhaps, better indicated than by the manner in which the executive offices have overflowed the limited facilities available in Washington. Indeed, the problems of housing the shipyard workers have not overshadowed in depth of perplexities the necessities of providing working space for hundreds of executives and clerical workers. From that standpoint it might be urged that Washington is not an ideal headquarters for so vast an industrial enterprise; but, for that matter, what community would have been qualified to extend instant hospitality to an institution comparable in magnitude only to the United States Steel Corporation? This is the answer to the efficiency expert who regrets that decentralization represented by Fleet Corporation occupancy of fourteen rented office buildings scattered throughout the business district of the capital. When requirements expand in a twelvemonth from a suite of four offices to several thousand rooms—an aggregate of about eight acres of floor space—business beggars cannot be choosers.

Office Space at a Premium

That the process of organization of the Emergency Fleet Corporation should have been in any degree complicated by uncertainties as to office arrangements is, of course, to be regretted, but it is doubtful if the proposal which at one time was considered to move bodily to Philadelphia would have helped matters. Ultimately it is expected that Congress will perceive the extravagance of paying out upward of $200,000 (£41,000) a year in rentals, and will authorize the erection of a single big building that will provide space under one roof for all the divisions and departments of the Fleet Corporation.

Whereas the Fleet Corporation in the basic essentials of its organization follows the make-up of some of the most efficient private corporations in the shipbuilding field, it has from the very nature of things been necessary to amplify the framework. For example, the purchasing division, the production division, the executive and administrative division and certain others follow, in the main, the functions of their equivalents in private shipyard practice; but in the case of such units as the transportation division, the labor division and the national service division it has been necessary to undertake special responsibilities on a scale unknown to private shipbuilding practice.

As an example of the unusual obligations of this shipbuilding organization, there might be cited the responsibilities of the national service division, of which J. Rogers Flannery is manager and Meyer Bloomfield is assistant manager. No ordinary welfare work is the forte of this section of the organization. Superimposed upon the ordinary problems of sanitation and industrial service is the liability of housing the shipyard workers—a $20,000,000 (£4,100,000) project in itself. In order to create satisfactory living conditions for the shipyard workers, this branch of the Emergency Fleet Corporation has been vested with powers perhaps more autocratic than have ever before been conferred on a public or private organization. Not only may it build dwellings as needed, but it may commandeer existing buildings, dispossessing owners or tenants at will.

Housing and Transportation of Shipyard Workers

At that, the responsibility upon the service division presupposes no policy of blind confiscation. In the case of each shipyard to be served, the organization is authorized to resort to commandeering or to new construction only in the event that it is found that local transportation facilities cannot be adapted to the conveyance to and from work of large bodies of men for whom ready-prepared housing accommodations are available at points more or less distant. With the transit problem unsolvable and no chance to billet shipworkers on the population or to commandeer suitable residences, the organization may

proceed to construct. Even here, however, we see the manifestation of that standardization which is to be the keynote of Emergency Fleet administration.

Insurance of Ships and Plants in the Hands of the Fleet Corporation

Picking at random, as it were, another illustration of the burdens which distinguish the Emergency Fleet Corporation organization from the system characteristic of private shipbuilding, there may be cited the responsibilities of the auditing division with respect to insurance. The Fleet Corporation provides all its own insurance upon ships as well as plants, instead of placing the risks with commercial companies, and, in consequence, an important cog in the machine is the insurance department, which is in charge of all insurance operations. In passing, it may be noted, too, that the auditing division, under D. H. Bender, general auditor, exemplified another tenet of the Emergency Fleet code—namely, the effort for simplification of routine. The division has supervision over all matters of auditing, accounting, payments under contract, etc., but the mobilization work at Washington is handled by a surprisingly small staff, thanks to a field organization of district and local auditors in each division on the shipbuilding map. As a result of intensive work in the field, the reports that are received at auditing headquarters at Washington are, as one official aptly put it, "predigested."

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Edward N. Hurley, Chairman of the Shipping Board

Shipping Board to Operate the Ships

Readers of this magazine who are familiar in a general way with the relations between the United States Shipping Board and the Emergency Fleet Corporation realize, of course, that the latter might be designated the constructive end of a dual governmental enterprise. In other words, the Fleet Corporation builds the vessels, be they of steel, wood, concrete or composite construction—and be the contracts on a "hull only" or "complete ship" basis—and when the tonnage is completed turns it over for operation to the Shipping Board, which is, in effect, an operative department. Whereas the members of the Shipping Board may, in the capacity of trustees, control the Fleet Corporation and its policies, the active management of shipbuilding operations is in the hands of the Fleet Corporation, a body that, following disappointments in its early career, was reorganized last November in a manner to centralize authority much after the fashion that authority is vested in private shipbuilding corporations.

Speaking recently of the development of the Emergency Fleet Corporation, President Edward N. Hurley said: "The organization has been expanded not only with the idea of checking up and safeguarding the expenditure of the vast sum intrusted to our care, but with the idea of infusing both into the contracting shipbuilders and the workmen engaged in the art that degree of enthusiasm for the work and interest in it that is absolutely essential to the carrying out of our purpose. We have recognized that it is necessary not only vastly to expand the number of men, and therefore to evolve a method of getting an adequate supply of labor and training it if necessary, but we have also been convinced of the necessity of spending more time in training up the executive and technical organizations in those plants which have undertaken contracts for which their experience does not particularly fit them. The big problem we have before us is to secure an adequate supply of experienced labor and competent shipyard organizations to direct it."

These remarks by the active head of the governmental institution disclose illuminatingly how intimate is to be the contact between the Emergency Fleet Corporation organization and the private shipbuilding interests of the country engaged upon government work on any basis. Furthermore, the comment will enable the reader to estimate the importance of one of the least understood sections of the organization, namely, the shipyard plants division. This division, under the management of Rear Admiral H. H. Rousseau, U. S. N., not only determines the eligibility of existing shipbuilding plants for Federal contracts, with a view to the type of construction involved in each case, but acts in a supervisory or advisory capacity with reference to new plants which are planned in anticipation of participation in the Government's shipbuilding programme. This task in itself involves a wide range of responsibility and technical knowledge.

Scope of the Shipyard Plants Division

While on this angle of the subject it may be further added that the division of shipyard plants exemplifies perhaps just a little better than any other that extreme elasticity which has characterized the whole Emergency Fleet organization. The circumstance that new offshoots to the main body have been created "over night" cannot be taken as evidence of vacillation on the part of the men at the helm, but rather as evidence of a determination to obviate delays by close and direct supervision. Given jurisdiction over matters of fire protection at the shipyards, the shipyard plants division organized a department of fire protection to design and install fire protective systems. Latterly this has been augmented by a department of shipyard protection, which is entrusted, among other responsibilities, with the task of organizing among the employees shipyard fire departments. What seemed in

prospect to require a fine distinction between these two "safety first" departments is in reality represented by a sharply defined line and attests the possibilities of that specialization that is the keynote of Emergency Fleet organization.

Production Division

The fact that the chore of the Emergency Fleet Corporation is to an extent unappreciated by some outsiders, not merely the construction of new ships, but more particularly the fabrication of new facilities and the construction of new shipyards explains some unusual attributes of the makeup of the organization. Take, for example, the attention bestowed upon the production division, of which M. C. Tuttle is manager. To this division, one of the newest in the organization, might be ascribed by the layman the duties that in reality fall to the construction division. Instead of concerning itself with vessel construction, the division of production is to concentrate on equipment. On the one hand it speeds up the production and delivery of machinery and other equipment required for ships that are not turned over to the Government in a completed state. On the other hand, it aids private shipbuilders holding Government contracts to get delivery of equipment needed for the fulfillment of their obligations—a most important service in these days of freight embargoes, car shortage and labor shortage that is curtailing the output of many factories. It is via this channel that there will be established the contact between the Fleet Corporation and scores of accessory manufacturers, such as the makers of winches, steering gear etc., etc.

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Charles Piez, Vice-President and General Manager, Emergency Fleet Corporation

How the Contracts Are Handled

From the complexity of the relations between the Emergency Fleet Corporation and the various shipbuilding concerns that are carrying on construction on one basis or another, it is obvious that the contract division must assume a place of considerable importance in the organization. The burden of Manager George S. Radford and his aids is made all the heavier by the diverse forms of contracts that are negotiated. In the early days of the Corporation some contracts were let on the cost-plus basis —that is, under an arrangement whereby the contractor receives the actual cost of the vessel plus 10 percent. Latterly this form has given way to contracts at a flat price or on a definite fee basis. However, as wheels within wheels, we have variations of these standard contract forms. Thus, a flat-price contract may incorporate an agreement whereby the governmental institution engages to take care of expense involved by any increase in the labor scale that may go into effect after the signing of the contract. Similarly, provision has of necessity been made in many cases for increases in the cost of material, and the outcome of this contracting policy has been to impose upon the contract division a vast amount of preliminary correspondence.

The contract division has done much for the stabilization of the American shipbuilding industry in general by its efforts to see to it that no attempt is made to, so to speak, jam square pegs into round holes. Contract Manager Radford, who has, in days gone by, drawn contracts for the Remington Arms and some of the largest manufacturing establishments in the country, as a prelude to contract negotiation, investigates not merely the shipbuilding experience and financial responsibility of each prospective bidder, but likewise all the physical aspects of the proposition. He wants to know, for example, whether the site selected by a new entrant in the industry is well suited for merchant shipbuilding, and he is doubly anxious that no contract shall go to a new builder who plans to muster his operative force by taking away men from present employment in other shipbuilding plants. In order to facilitate the first-hand investigation that paves the way for actual contract making the contract manager turns to the district manager in the territory involved, and this local or district manager in turn assigns the actual investigative work to his inspectors, whose duties thus comprise all manner of "intelligence work" bearing upon new or proposed shipyards, as well as the routine inspections of shipbuilding work in progress that give the O. K. to payments on continuing contracts.

So much has been printed with reference to the shortage of man-power in the shipbuilding industry that there is little need to emphasize the opportunity which lies before the labor division of the Emergency Fleet Corporation which, under the direction of William Blackman, grapples with all phases of the problem of procuring and distributing men from mechanical trades as well as laborers to the various shipyards throughout the United States. A successful idea, as developed in this quarter, is found in the employment bureaus established by the Emergency Fleet Corporation. Where all shipbuilders in a given district, as, say, on Puget Sound or in the vicinity of Philadelphia, agree to employ all needed labor through the one central agency, it is found that the co-operation works to the advantage of all concerned. The labor division is called upon to appear in a conciliatory role when labor troubles arise, and it works at all times in close harmony with the "welfare" sections of the national service division in an effort to create an atmosphere of contentment in all shipyards.

The General Manager's Duties

If there is steady improvement in the relations between the shipbuilders of the United States and the Emergency Fleet Corporation it must be attributed in no small measure to the reorganization which has squared the administrative practice of the Fleet Corporation with that followed by large corporations in general. Under the rearrangement, the general manager is no longer clothed with absolute power over the entire conduct of affairs. As matters now stand, General Manager Charles Piez, who has been indefinitely "loaned" to the Emergency Fleet Corporation as a result of his work in conjunction with Messrs. Mason and Day on the productive committee that investigated the American shipyards, is an appointive officer to whom certain functions are delegated. As the reorganized Emergency Fleet Corporation stands to-day, the executive control of the management is vested in the president, who may delegate any of his powers to such officers as he may elect. In this connection it may be of interest to quote the reply which General Manager Piez recently made to a critic who was inclined to question his suitability for his post on the ground of his lack of practical shipbuilding experience. The come-back of Manager Piez was in this wise: "I have had engineering training and for many years acted as an engineer. The problems in any large organization are not wholly technical. There are many problems of policy, of management and of organization that are in most cases of greater moment than are the technical problems."

As is essential in order to preserve the proper balance whenever administrative direction is in non-technical or semi-technical hands, we find in the case of the Emergency Fleet Corporation executive authority supported by such technical aids as Rear Admiral Bowles, the assistant manager. The construction division, over which the latter has presided, has complete supervision over all matters connected with the design and construction of vessels, the control of production and the inspection of work upon vessels under construction. To the technical department within this division belongs whatever credit attaches to the evolution of the designs for standardized ships which have played so prominent a part in the policy of the Fleet Corporation—namely, the Ferris type of 3,500-ton wooden ships and the standard ships of 5,000, 7,500 and 8,000 tons, respectively, that are being fabricated in the agency yards of the Corporation.

Construction Division

It rests with the construction division and its subordinate technical department to conduct the distribution of contracts in accordance with the Corporation's prearranged shipbuilding programme, which contemplates the provision of so many cargo vessels of this size and of that. No contract prepared by the contract division after consultation with the construction division is, however, formally approved or signed until it has been passed upon by the legal division, under the direction of John Barton Payne, general counsel. Indeed, whereas the contract division handles all the preliminaries incident to contract making, not forgetting investigations of credits, it is the legal division which actually draws up the contracts after the general terms have been agreed upon. Logically, then, it is this selfsame legal division which later handles all questions arising with respect to the obligations of the Corporation under its contracts and that considers all claims made against the institution by shipbuilders under contract or other interests.

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James O. Heyworth, Manager, Division of Wood Ship Construction

Purchasing Division

The Emergency Fleet Corporation, as becomes a going concern, has its purchasing division for the purchase of raw and finished products, but the incidents that during recent months have grown out of the difficulties encountered in getting the specified yellow pine necessary to carry out the wooden shipbuilding programme eloquently attest how far it is necessary for the division headed by General Purchasing Officer Frank A. Browne to exceed the activities of the ordinary industrial buying agency. It goes without saying that with upward of 400 wooden vessels under construction requiring an aggregate of close to 375,000,000 feet of Southern pine a man-size job

confronted the purchasing officers, and this responsibility was complicated when it was discovered that the timber required exceeded the total production of suitable long-leaf Southern pine for the year.

Difficulties Overcome by the Purchasing Division

It was in the face of this dilemma that the purchasing annex of the Emergency Fleet Corporation proved its ingenuity by placing representatives in the Southern territory who were not only able to communicate accurate information as to supplies, but likewise formed an effective organization for the conservation of such material as was available. For one thing, inspectors were placed at the mills to inspect every piece of lumber that came from the rack to determine its suitability for shipbuilding use. Then, finding that mill owners were yielding to temptation to sell lumber to private consumers who offered higher prices than called for by the contracts of the Emergency Fleet Corporation, the latter's purchasing division clapped on, through its field men, an embargo which has effectually prevented any interest from selling any lumber over 12 inches wide or over 2 inches thick that would be adapted for ship construction. The Corporation's purchasing officers were given authority to take over and operate any mill the management of which was detected in violation of the embargo, and the whole incident has been enlightening as to the power of a buying agency that must be reckoned with in all sections of the material market so long as Uncle Sam continues to build ships.

In the rapid expansion of the Emergency Fleet Corporation organization the greatest attention has been paid to the development of the agencies for the rendering of industrial service, using that term in its broadest sense. It was felt that the majority of the private shipbuilders of the United States, not having conducted, in the pre-war period, an especially profitable industry, might not have been able to adopt the best and most modern methods with regard to the employment of men and the creation of ideal working conditions. Accordingly, all the plans of the Fleet Corporation have contemplated the upbuilding of machinery designed not merely to recruit the shipyard forces to full strength, but to hold the roster at full strength and to maintain the morale of this industrial army at the highest point. We have the tangible manifestations of this ambition in such innovations as the shipyard volunteer reserve, and the department of industrial training, the latter having supervision over the training schools for training men for shipyard operations.

"Industrial Plattsburg" Established for Training Shipbuilders

The most important feature of the Fleet Corporation's industrial service work has been the effort to build up a dependable force of skilled labor for the shipyards by means of vocational training. With all American shipyards showing an average annual turnover of employees approximating 300 percent and with some of the largest yards disclosing annual labor turnover of 600 percent, there is manifest opportunity for anything calculated to put shipyard labor on a higher plane. The "industrial Plattsburg" that the Fleet Corporation has sponsored is counted upon to turn out skilled mechanics at such a rate that by force of example and by the instruction imparted man-to-man by these non-commissioned officers of the shipbuilding army there will be created a qualified operative force at the rate of 50,000 per year. By way of meeting the shipbuilders half way in this vocational training drive, the Fleet Corporation allows to a shipbuilder the sum of $5 (1/0/10) per day for the tuition period of six weeks for every skilled man detailed to the Corporation's training school. To the shipbuilder who establishes a training center at his own yard the Corporation makes allowance of $1 (4/2) per day for each man (for an interval of 78 consecutive days), half of this allowance going to the shipbuilder and the other half to the employee as a bonus for taking the training. Likewise, contributory to the consistent effort to create a permanent organization of skilled shipyard operatives is the shipyard volunteers' movement, with its badge of honor and certificate of enrollment for every worker who enrolls for shipyard service when called upon.

In its threefold effort to assist the shipbuilders of the country to "get men—keep men—fit men," the industrial service department, or national service division as it is now known, proceeds in accordance with a definite formula. First of all, each shipyard is helped to organize a centralized employment department, so that an end will be put to promiscuous hiring and firing with its consequent high "mortality." The Emergency Fleet Corporation experts have proven to their own satisfaction and are now endeavoring to prove to the satisfaction of shipbuilders throughout the country that leakage of men from the yards will be greatly reduced if the power to engage and discharge help is lodged in one place—in the hands of one intelligent, well-paid, responsible man, in the case of each yard. The industrial service department of the Fleet Corporation, without presuming to dictate appointments, has recommended to shipbuilders who have asked advice various high-grade men for employment managers in the yards, and it is no exaggeration to say that the system is passing whereby every foreman and sub-boss in the yard can dabble with the employment proposition. It should perhaps be added that the idea at the Fleet Corporation is that all changes in shipyard personnel should be with the advice of the foremen or other executives, whose interests are most directly concerned, but the idea is to have men "cleared" in each yard through one office. In connection with the establishment of a centralized employment department, the national service division seeks to help each shipbuilding firm to perfect a system whereby additional employees will be called for only as actual needs develop, and means will be provided promptly to absorb newcomers as rapidly as they arrive.

Labor Problems Handled by National Service Division

A second activity on the part of the national service division has been the recruiting from technical schools and colleges of men qualified to assume subordinate positions of some responsibility. At the same time there has been conducted at the shipyards throughout the country a series of foremen's meetings designed to instruct foremen how to handle the working forces to the best advantage and in a manner to secure the greatest stability. Another move in this same direction—that is, in the effort to keep hold of the men once secured—aims to build up in each shipyard an elastic system of transfer. The purpose of such an adjunct to shipyard organization is, of course, to bring about the speedy shifting of misfits to other environment in the same yard where they might be able to make a better showing. In the last analysis, it is all part and parcel of the studied effort to reduce the shipyard turnover. And, as Rear Admiral Harris recently remarked, this goes to the very heart of the shipbuilding problem of the period. The erstwhile executive of the Fleet Corporation, when asked if his tentative prediction of 6,000,000 tons of shipping in 1918 would be realized, replied: "It is very apparent from talks with shipbuilders that unless we can do something at the yards to get more workmen and keep them there contented and keep them

from going away and prevent such continuous turnover it will be impossible to make any forecast and live up to it."

In the industrial service annex of the Fleet Corporation there is an exemption section which deals with a subject of vital importance to all shipbuilders, namely, the release from military service or liability to military service of men qualified for shipyard work. Under the existing selective draft regulations shipbuilders may secure the exemption of their men, or rather may secure the substitution of shipyard employment for military service. Going a step farther, the organization above indicated made an arrangement with Secretary of War Baker whereby valuable men who have been withdrawn from the shipbuilding industry and are actually in the army may be returned to their previous employment on request of the shipbuilder. Hundreds of men have by this arrangement been restored to the shipbuilding industry. Most of the men thus shifted obviously exert every effort to make good in the shipyards, because if they do not come up to the responsibilities which their discharge back to the shipyard contemplates, they can be certified for recall to the army. An integral part of this system is found in the obligation upon the Fleet Corporation and the employing shipbuilder to report during the first five days of each month to the proper local exemption board that each man upon whom the army has waived its claim is yet engaged in shipbuilding.

Whirlwind Campaign for Shipyard Workers

While the Emergency Fleet Corporation, through its national service division, is doing much work direct to build up a shipyard army—for example, the "missionary work" of the field men, who have been traveling to every technical school and college of any importance—other efforts are in co-operation with the employment service of the U. S. Department of Labor. We may observe how this "team work" is applied by turning to the case of the United States shipyard volunteers of the public service reserve, which, as the result of a whirlwind campaign has now reached its full quota of 250,000 enrolled men. Whereas a department of the Fleet Corporation has exploited this movement and has, as noted above, issued badges and certificates, the work of registration has been in the hands of the enrollment agency of the United States public service reserve of the Department of Labor, and it will be through the Department of Labor that the enrolled volunteers will be summoned to serve in the shipyards as the gradual expansion of the plants provides places for the recruits.

Gigantic Transportation Problems

Even with all the aid that may be given by means of special "priorities" and "exceptions" to freight embargoes, there is a heavy responsibility devolving upon the traffic department of a business institution that is larger than the Standard Oil Company, larger than the United States Steel Corporation, and, in point of expenditures, larger than the United States Navy Department. The transportation division of the Emergency Fleet Corporation, of which F. C. Joubert is manager, is, in effect, the equivalent of the traffic department of a large industrial corporation, and yet it stands in a class by itself by reason of two special factors involved. One is the magnitude of the operations required—the necessity of keeping traffic moving to and from not a single factory, but dozens of plants in widely separated sections of the country. The other unusual element is the extreme urgency of virtually all freight movements in which the Fleet Corporation has an interest. The every-day production plant in almost any line may be in urgent need of a given piece of equipment or one class of supplies, but with the Fleet Corporation, an industrial giant virtually created "overnight," the "must" tag is on practically every shipment, great and small. To the transportation division comes the plaint of the manufacturer who cannot get cars to load chain and the protest of the shipbuilder who, with a keel laid, finds progress arrested because of the non-arrival of steel.

Every effort is made to insure the requisite close co-operation between the purchasing division and the transportation division. The purchasing division has obtained its information in regard to what is to be purchased from the engineering department. Bids under the ordinary specification are asked within a short period, say ten days, and the submission of bids by telegraph is encouraged. When it comes time to place orders or close contracts the element of transportation is taken into consideration and the transportation division may be consulted as to traffic conditions in the territory involved. Every effort has been made to place with firms on the Pacific Coast contracts for equipment and supplies for the vessels building on the west coast, not merely in order to distribute the business as equitably as possible, but likewise to relieve to as great an extent as possible the tax upon transportation facilities.

Acting as the nerve center of 150 shipyards, more than half of which have been established during the past year, and spending money at the rate of from $3,000,000 (£615,000) to $5,000,000 (£1,025,000) per day, the Emergency Fleet Corporation has developed an administrative organization singularly qualified for grappling with a mass of problems, a large portion of which, as fate would have it, are problems somewhat beyond the scope of ordinary shipyard direction. Of the 1,570 members of the executive staff of the Fleet Corporation not all, by any means, have won their spurs in American shipyards, but a surprisingly large proportion, if they did not serve apprenticeship in the shipyards, have qualified by connection with interests closely akin to actual ship construction. That the majority of the Fleet Corporation executives have made good is eloquently attested by the offers that have come to these men from private shipbuilders of places in their organizations—offers so liable to prove distracting that General Manager Piez has lately found it necessary to appeal to shipbuilders not to take away any of his employees so long as the war continues. It is an organization that is expanding so rapidly that no organization chart is up to date for more than 24 hours, but it is an organization that will "carry on."

Our New Merchant Marine

BY HENRY HOWARD*

THE sea's call to our country's youth to-day is clear and strong. At no other period in our national life has need been greater than now for fearless men to carry our flag through stress of war and storm to foreign ports.

The American merchant mariner of to-day takes rank in the greatest of all wars—the ultimate struggle of Liberty with Force—beside his honored brothers of the army and navy, an exemplar of the strength and plenty of this free and chivalrous New World. In his hands we trust our trade; but more than this, we trust our honor, too. Neither shall perish so long as our mariners sail the seas.

On a thousand new ships now taking shape upon our shores American merchant sailors by tens of thousands will go forth without fear. Veterans in sea service will have trained the newcomers to the fleets—and so will be wrought a strong, close-knit, all-American personnel for our reborn merchant marine.

* Director of Recruiting Service, U. S. Shipping Board.

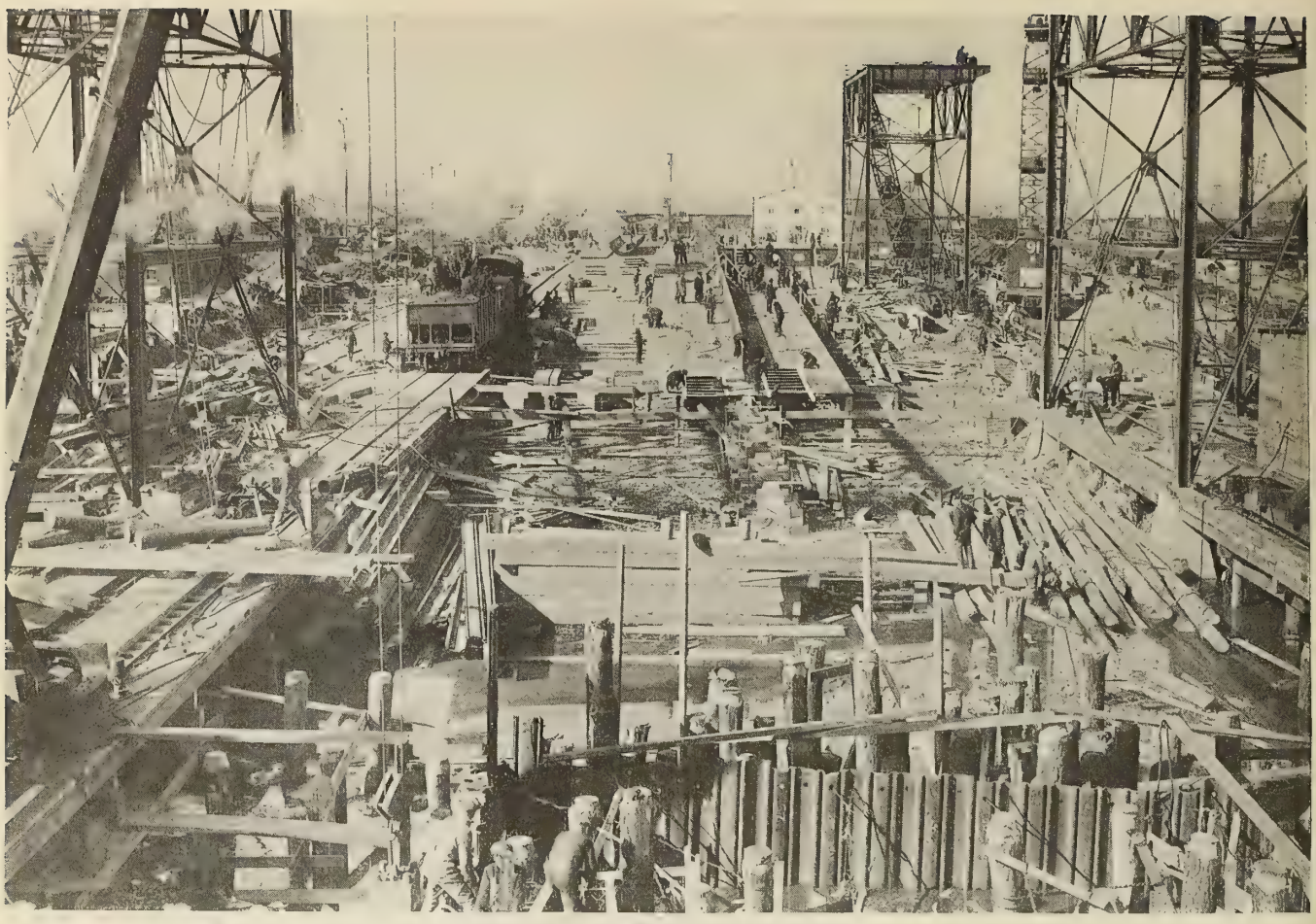


Fig. 1.—Cofferdam in Front of Shipway under Construction

Hog Island Yard Starts Building Ships

Great Government Plant Ahead of Schedule—Fifty Ships to Be Launched this Year—Over 30,000 Men Employed

NEVER before in the history of shipbuilding has such a colossal task been attempted as that assigned to the American International Shipbuilding Corporation by the United States Shipping Board, calling for the construction of nearly a million tons deadweight of merchant vessels within eighteen months. The undertaking involves expenditures amounting to two-thirds the cost of the Panama Canal and must be completed in about one-fifth the time required for that project.

To carry out this huge enterprise, a yard containing fifty building ways, and seven 1,000-foot fitting out piers, is being constructed at Hog Island, on the Delaware river, just below Philadelphia. This site, comprising 850 acres, has a water front of about two miles and extends back from the river about one mile. Although preliminary plans for the project were discussed with the Emergency Fleet Corporation last May, the contract calling for the construction of the yard, and the building of fifty 7,500-ton deadweight cargo vessels of 11½ knots speed, was not signed until September 13, and this was supplemented on October 23 by another contract for seventy additional vessels of 8,000-tons deadweight and 15 knots speed. For the construction of the plant, the American International Shipbuilding Corporation is to receive no remuneration, but it will receive a minimum fee of $41,000 (£8,400) for each of the smaller ships and $65,000 (£13,320) for each of the larger ships, with bonuses or penalties of $300 (62/10/0) a day for anticipating or failure to meet the contract schedule, the total bonus, or penalty, in each case being limited to $14,000 (£2,660).

Two Types of Ships to Be Built

The vessels are all single screw steamers, fitted with geared turbines and watertube boilers. The 7,500-ton ships are 401 feet long overall, 390 feet long between perpendiculars, 54 feet molded beam, 32 feet molded depth and 24 feet load draft. The hull is divided into five cargo holds with oil fuel bunkers alongside the boiler room. The 8,000-ton ships are 450 feet long overall, 435 feet long on the waterline, 58 feet molded beam, 40 feet depth to the upper deck and 28 feet load draft. The weight of the steel hull is 3,400 tons; the weight of the machinery (with water), 750 tons, and the total weight of the ship, light, 4,460 tons. With a deadweight carrying capacity of 8,000 tons, the total displacement is 12,460 tons and the gross tonnage 6,200. These vessels are fitted with geared turbines of 6,000 horsepower, designed to give a speed of 15 knots and a cruising radius of over 8,000 nautical miles.

Fig. 2.—Template Shop

The building of the ships will be carried out in eight-hour shifts, which with overtime and day and night shifts will keep the plant in operation practically continuously. About 35,000 men will be employed when shipbuilding operations are in full swing.

Speed of Construction the First Consideration

Speed of construction is the keynote of the whole project. As work was not begun until fall, it had to be carried out during winter months when the weather conditions were unprecedented in their severity. Delays in transportation, due to congested conditions of the railways, added to adverse weather conditions, imposed difficulties and hardships which could be overcome only by almost superhuman efforts. In spite of the initial difficulties, however, the work has progressed satisfactorily. All of the fifty shipways are well along toward completion. Ten are ready for keels, and construction of vessels has begun on two of the ways. It is confidently predicted that, barring unforeseen delays, fifty ships will be launched this year, and the entire contract completed on schedule time.

In the design and methods of construction of the vessels, the system of fabrication has been developed to take advantage of its maximum possibilities. Every detail of the ships has been worked out so that its manufacture in quantity requires the fewest number of operations. Ordinary ship lines are replaced by flat work in so far as possible; that is, the sides and bottom of the vessel are straight for the maximum distance amidships, the decks are without crown or sheer and other details are accordingly simplified. Over 95 percent of the steel that goes into the ships will be fabricated outside of the yard and delivered ready for erection and riveting. As originally laid out, the yard provided for the construction of a single type of vessel, but, with the later addition of a second size ship, it was found necessary to rearrange the yard and provide two separate main storage and classification yards for the material.

Essential Features of the Yard

As the yard is virtually an assembling plant, the essential features are the building ways, of which there are fifty, extending along a mile of the river front, the fitting out piers, of which there are seven, 1,000 feet long and 66 feet wide, and the material storage and

Fig. 3.—Administration Building

Fig. 4.—Group of Workmen's Barracks

classification yards, storehouses and such shops as are essential for the fabricating work, which is done in the yard. Thirty-six miles of railroad track have already been laid in the yard, and the buildings, including shops, barracks, mess halls, storehouses, training school, hospital, etc., will cover 20 acres. Twenty-five locomotives and 500 flat cars, owned by the Emergency Fleet Corporation, are operated in the yard. When shipbuilding operations are in full swing, 50 to 100 carloads of material will be received each day. Complete water and sewage systems are being provided of sufficient size, it is estimated, to serve a city as large as Minneapolis.

Construction of Shipways

The fifty shipways are laid out in groups of ten each, making virtually five separate shipyards. Ten of these ways are of concrete construction, while the other forty are of wood, supported on wooden piles. The ways are spaced 105 feet between centers, and for the 7,500-ton vessels, are 400 feet long, and for the 8,000-ton vessels, 450 feet long. Between each of the ways are four steel derrick towers, 66 feet high, 23 feet wide and 47 feet long, each of which carries two derrick booms of sufficient length to serve the entire width of the shipways; thus, each vessel will be served by eight derricks. The crane towers are offset on one side of the shipways to allow space for a railroad track to extend down to the water front.

To bring the depth of water in front of the ways to 18 feet, about 1,000,000 cubic yards of spoil is being dredged out. Further down the river, at the fitting out basin, where the present depth of water is 6 feet, about 3,000,000 cubic yards is being dredged out, the spoil being handled by hydraulic dredges and deposited in a marshy area back of the shipyard proper. The fitting out piers will have accommodations for 28 vessels at one time, and will be equipped with electric gantry cranes.

Railroad Connections

The yard has direct connections with the Pennsylvania and Philadelphia and Reading railroads, which lead into the storage and classification yards. The main storage yard is over two miles long, but holds material for only a two weeks' supply. In the storage yards the tracks are laid in groups of three, with a single track running through the center of the storage space between the groups.

Fig. 5.—Concrete Shipways

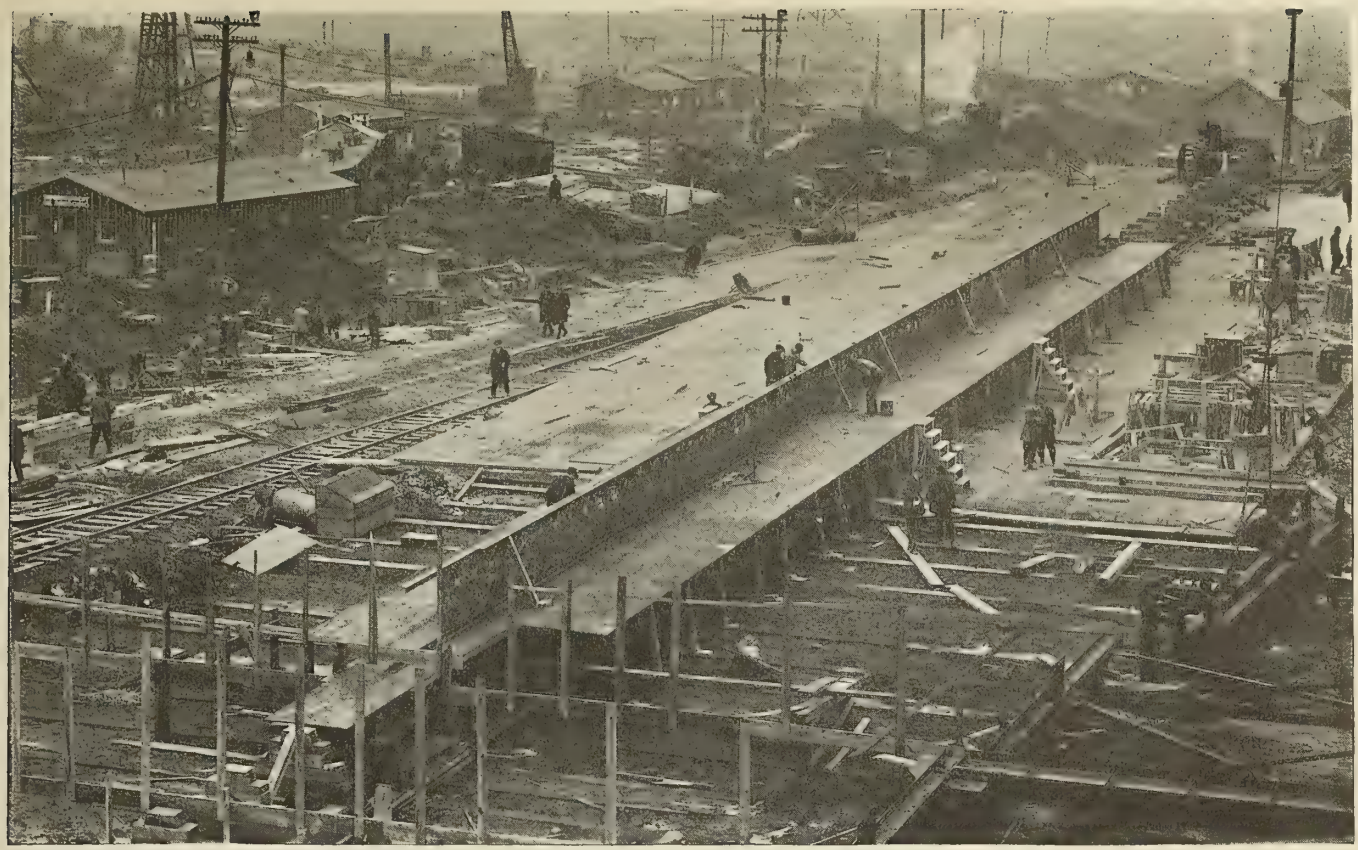


Fig. 6.—Laying the First Keel, Shipway No. 1

Fig. 7.—Shipway No. 1, from River Front

Shops and Service Buildings

Near the main entrance to the yard, which is at the center of the site, is a group of buildings, including a two-story, three-wing administration building, an engineering building containing the drafting departments, a brick bank building, a two-story hospital containing four wards with a total of 101 beds, garages and a fire-fighting station. Some of the principal shops are of large size, including a steel frame plate and angle shop, 638 feet long by 223 feet 3 inches wide, built on concrete foundations resting on piles. This shop is divided into three bays, served by six overhead traveling cranes of 10 tons capacity each. Foundations for the heavy machine tools are of concrete on piles. The floor is of cinder. Nearby is a plate and angle correction shop, of the same length, but one-third the width, of similar construction. There are two machine shops, each 200 feet long by 60 feet wide; two smith shops, one 275 feet long by 60 feet wide, the other 250 feet long by 60 feet wide, a smith annex, 120 feet by 60 feet; a pipe shop, 200 feet by 60 feet; a galvanizing shop, 100 feet by 50 feet; an air tool shop, 187 feet by 60 feet, and a template building, 400 feet long by 60 feet wide.

Template Shop

The template building is of steel frame construction with corrugated iron sides, up to the windows, which are in steel sashes. As the building is heated, it is sheathed inside, and there is a loft on one side of the building for the storage of patterns. The floor in this building is a special feature, and is entirely separate from the building itself. It is laid on 6-inch by 12-inch girders, spaced 10 feet apart and running lengthwise of the building, with joists 3 feet apart. The floor rests on piles with wedges driven in between the piles and the flooring, so that it can be leveled up at all times to a true flat surface for mold loft work. The floor itself consists of 2-inch, tongued-and-grooved yellow pine, running lengthwise of the building, over which are two layers of felt paper, topped by 1½-inch Michigan white pine uppers, painted gray.

There are also two separate buildings, known as boiler template shops, in each of which is to be assembled a complete boiler with fittings, for the ships under construction. At one end of the yard is a building 125 feet long by 23 feet wide, with an extension 20 feet by 23 feet, to be used as an instructor's training school for shipyard workers. This school is in charge of Dr. C. R. Allen, former head of the Department of Industrial Education in Massachusetts, and more recently in charge of the Emergency Fleet Corporation Training School at Newport News. The building will accommodate a class of 150 at one time.

Just outside of the yard are barracks for housing 5,000 workmen and two large restaurants. Sixty-two barracks have already been completed; one hundred are projected.

Power Supply

Power for operating the plant is taken from a local supply, the largest requirement being for the compressed air plants, which total 15,000 horsepower and compress 75,000 cubic feet of free air per minute, making this the second largest air compressor plant in the world. One compressor house is provided for each group of ten ways, each house containing three sets of electrically-driven air compressors, each with a capacity of 2,200 cubic feet. For driving the machinery in the yard, some 600 motors are required, totaling 28,000 horsepower. There is also a central heating plant and a high pressure pumping station for the general yard and fire service.

The keynote to success in carrying out the system of ship construction, adopted at this plant, lies in an elaborate system of production-control and transportation. The production-control system is so developed that it will be possible to tell, in a few minutes, the number of every article going into the ships, which is in the yard, the spaces available for material, the number of parts ordered and the number that are en route to the yard. Upon this production-control department and the traffic department rests the burden for speeding up the building of ships. At the work on the ways, the men are divided into specialist gangs, each performing one particular operation. These gangs serve on one group of five ways and are shifted from one way to the next for each particular job, so that as the work on the fifth way is finished, a new ship will be ready for the same operations on the first way. The same progress from hull to hull is then repeated. With this systematic progress of the work by gangs especially trained for one operation, it is believed the work can be speeded up to the maximum output of the yard.

Officers of the Shipbuilding Company

Both the plant and the ships are being designed and constructed by the American International Shipbuilding Corporation acting as agent for the U. S. Shipping Board Emergency Fleet Corporation, and supervised by Rear Admiral F. T. Bowles, assistant general manager of the Fleet Corporation. The officers of the company are: G. J. Baldwin, chairman, board of directors; Frederick Holbrook, president; H. D. Connick, M. A. Neeland, H. L. Rogers and G. O. Muhlfeld, vice-presidents; Walter Goodenough, general manager, and J. H. Manning, chief engineer. T. A. Carr is works manager; J. T. Martin (formerly general manager Sparrows Point yard, Bethlehem Steel Corporation), general manager of ship construction; W. B. Fortune (Quebec bridge builder), general superintendent ship construction and derricks.

Valves can be so fitted as to have the pressure come on top of the clapper or disk, and when opened a clear passage is obtained. Against this is the fact that it is difficult, if not impossible, to pack the valve stem under pressure. On the other hand, if the pressure is underneath the clapper, it is forced from its seat, and when the valve and body expand the valve sometimes leaks, but packing is made easy.

Valve stem followers are difficult to remove when once forced down as far as they can go, as then there is no space between the end of the stuffing box and the rim of the follower. It is a good plan to file away the underside of the rim, beveling on opposite sides so a screw driver can be used to start the follower.

The uniflow engine gains its enormous economy largely from the fact that the cooled steam at the end of the stroke is exhausted quickly, thus making the ideal conditions of keeping the cylinders nearer the temperature of the incoming steam.

It is easy to make one thing accurate; it takes skill to make two things alike and genius to make many things alike, cheaply.

It is to be remembered that each nut on a valve chest or cylinder cover is there to do its bit, so set them down evenly.

Fig. 1.—Main Group of Buildings at Newark Bay Plant

Construction of Newark Bay Shipyard

Submarine Boat Corporation, as Agents of Emergency Fleet Corporation, Building 5,000-Ton Fabricated Ships

WITH over 1,000 cities and towns in the United States directly or indirectly interested in supplying material, labor and equipment for the one hundred and fifty 5,000-ton shops it will build, the Government fabricated steel shipbuilding plant on Newark Bay, erected and operated by the Submarine Boat Corporation, of New York, as agent of the United States Shipping Board Emergency Fleet Corporation, is in reality but one department—the assembling department—of an enormous shipbuilding enterprise. Located at Port Newark Terminal, only about four miles from the heart of the city of Newark, and with railroad and trolley connections to a territory populated by over 7,000,000, the yard is ideally situated for shipbuilding purposes.

On a delta formed by the Hackensack and Passaic rivers, which formerly was a marsh, but which in recent years, has been filled in by soil dredged from two sides in the development of Port Newark Terminal, the yard occupies an area of 112.5 acres with a water front of over half a mile on Newark Bay, where twenty-eight shipways have been built. Originally the depth of water at the waterfront was insufficient, but this is now being dredged out by the Government to the main ship channel in the bay, which has a depth of 20 feet. On the south side of the property is a slip 400 feet wide with a depth of water of 20 feet and a complete wharf 50 feet wide and over 4,400 feet long, which will be used as a fitting-out berth.

In the yard 15 miles of standard-gage railroad track connects the storage yards, shipways, shops and fitting-out berth. These tracks are directly connected with the Pennsylvania and Lehigh railroads and with the Central Railroad of New Jersey, so that the fabricated material from outside structural and bridge shops can be delivered direct to the heads of the shipbuilding ways.

As the plant is in reality but the assembling department of the whole shipbuilding process, the major features of

Fig. 2.—Exterior View of Two-Story Administration Building

Fig. 3.—Shipway at Newark Bay Plant

its layout center in the shipways, fitting-out berth and storage and classification yards. At the head of the shipways, which take up the entire water front, ample space is left for storing in front of each way all of the fabricated steel needed for a complete ship, one large derrick of 5 tons capacity with an 82-foot boom being provided at the head of each group of two ways. Back of this storage space is the main group of buildings with a two-story administration building in the center, flanked on each side by twin ship sheds and fabricating shops. Thus the hull building yard proper is divided into two separate units known as the north yard and south yard, but with identical equipment and arrangement.

Fig. 5.—Hotel and Restaurant

Back of the main buildings, and also in the center of the shipyard property, is the main entrance to the yard, with a railroad station, restaurant, garages and hospital. On one side of the railroad tracks leading to the passenger station are the main storage and classification yards for ship steel and a lumber storage yard, while on the other side and adjacent to the fitting-out berth is the fitting-out storage yard. From the main classification yard, tracks lead direct to the shipways, shops and fitting-out berth. Between each group of two ways a single track extends down to the bulkhead at the water front.

Shipways

All of the shipways are of wood, supported on wood piles. The underlying soil is a soft, wet silt and clay extending to an average depth of about thirty-four feet below the ground level; below that, a five-foot layer of clay and gravel generally exists. The piles on which the ways rest, therefore, are usually driven about thirty-six feet into the ground, bringing up in the hard layer. The required bearing capacity varies from eight tons per pile under the inboard ways to a maximum of seventeen tons on the outboard ways. In all, over 26,000 piles are required for the twenty-eight ways. For the inboard end of the ways, which extends 310 feet from the water, 18,000 piles

Fig. 4.—Keel of Hull No. 4, Laid at Newark Bay Plant. View Shows Shipway Derrick Towers

Fig. 6.—Interior of Administration Building, Second Floor

are required. For the outboard end, the piles are driven out about 150 feet into the water. The bents are thoroughly braced and capped with timbers, above which are placed the stringers and flooring for the ways. The declivity of the ground ways is 11/16 inch to the foot, and of the ship's keel and flooring of the ways 5/8 inch to the foot.

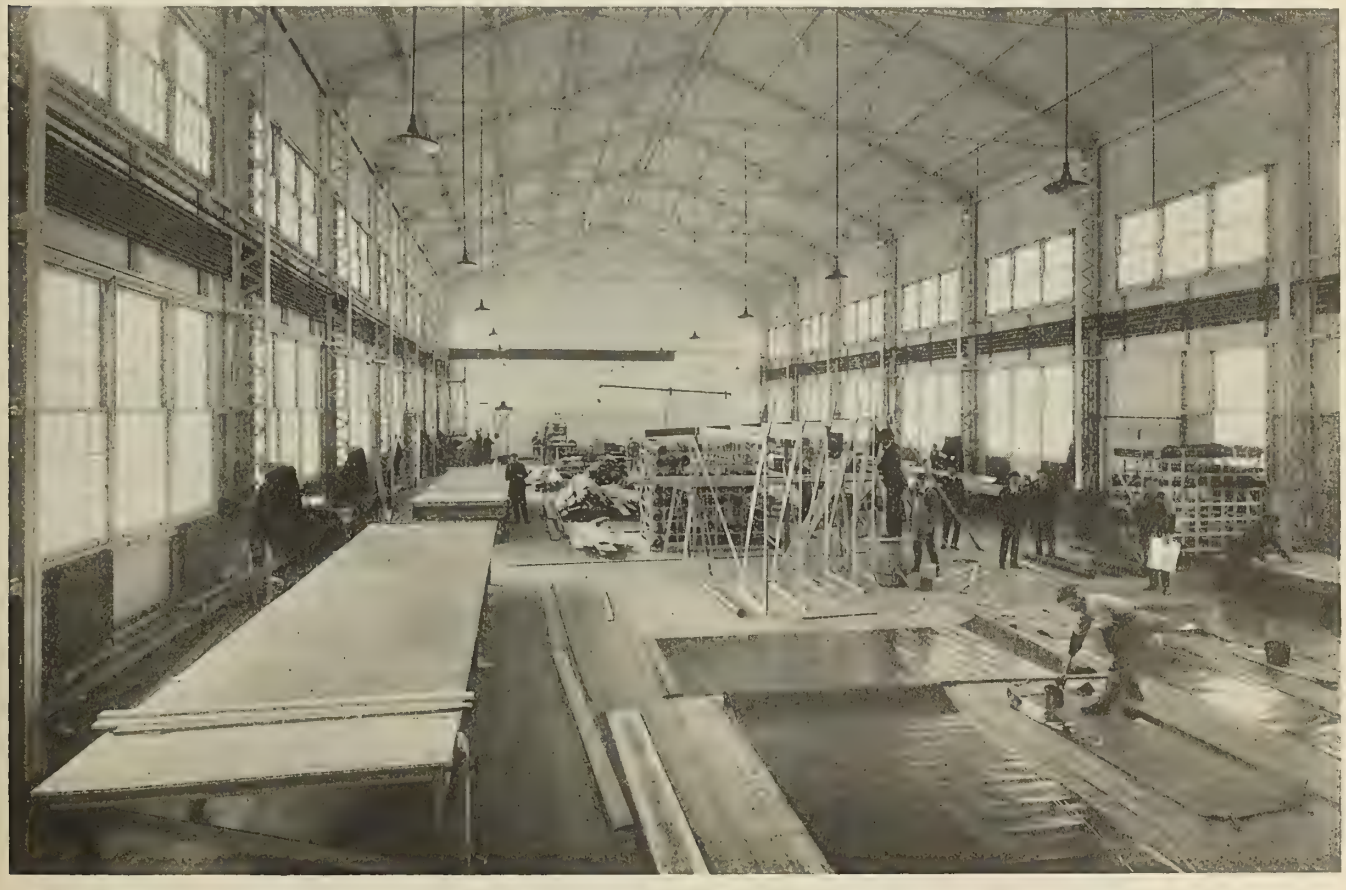


Fig. 7.—Interior of South Template Shop

At the head of the ways material is handled by derricks of 5 tons capacity with a boom of 82 feet, one being provided for each group of two ways. Between each group of two ways a railroad track extends down to the water's edge, so that material can be brought to any desired point along the length of the vessel. The material is transferred onto the ways by electrically operated derricks mounted on steel towers built between each group of twin ways, but on the opposite side of the way from the railroad track; thus between every shipway there is alternately the derrick cranes or the material track.

There are two derrick towers in each crane space between the ways, each tower carrying two derricks of 5 tons capacity and 87-foot radius. The derrick towers are each 28 feet wide and 74 feet long, extending up to a height of about 50 feet. The derricks are provided with separate motors and controllers for each motion; a 25-horsepower motor raises the load, a 35-horsepower motor raises the boom and a 5-horsepower motor swings the boom. For operating the motors direct current of 250

Fig. 8.—Scrive Board Room

volts is required, but, as the current received from the Public Service is alternating and at 13,200 volts, two substations have been built for transforming and converting the current for the derricks.

Cranes at Fitting Out Berth

At the fitting-out berth, electric traveling gantry cranes will be installed for transferring materials and equipment to the ships after they are launched. The largest of these cranes, weighing about 400 tons and extending 90 feet above the pier, will have a capacity of 50 tons.

Turning now to the buildings, the administration building is 196 feet long by 80 feet wide, with wood frame and stucco and glass walls two stories in height. The main floor is given over to the purchasing department, inspectors and yard executives, while the second floor is occupied by the chief executives, the representatives of the Emergency Fleet Corporation and their staffs and the engineering and hull drafting departments.

Back of the administration building is a two-story hotel and restaurant, 76 by 96 feet, of wood frame with stucco walls. The kitchen is on the main floor, together with a dining room with a capacity for 144 and a lunch room with a capacity for 87. The second floor is divided up into several bedrooms with private baths, a private dining room and lounge and reading room.

On either side of the administration building are the main north and south shops, identical in size and arrangement. The total length of each of these shops is 635 feet and the width 60 feet. At one end is the furnace shop, 60 by 100 feet, with the plate and angle furnaces and bending blocks. In front of this is the punch shop with gantry punches and a straightening and bending machine. Beside the furnace shop are the scrive boards, and beyond that the template shop, 60 by 160 feet, equipped with a band saw, wood lathe, boring machine, edger and crosscut rip saw. Beyond the template shop are the plate fabricating machines, consisting of a set of bending rolls, straightening rolls, plate planer, 60-inch plate punch, 15-inch detail punch, horizontal punch, bull dozer and wall radial drill. At the end is the smith shop. These buildings are of temporary construction, with light steel frame and corrugated iron walls bolted together, with the exception of the template building, which has stucco walls.

The machine and forge shops are housed in a building 40 by 240 feet, located alongside the railroad tracks back of the main south shop. At one end of the building is the machine shop equipped with three lathes, one 60 inches by 32 feet and the other two of smaller size, a 20-inch drill, a 24-inch shaper, a 5-foot radial drill, a bolt threading machine and drill and tool grinders. At the end of the machine shop is an electrical workshop, beyond that a storeroom, and then the forge shop equipped with a No. 3 Nazel power hammer, forge fires and pipe threading machines.

Along the fitting-out wharf are two buildings, each 420 feet long and 60 feet wide, which house a pipe shop, electricians' room, rigger and deck-fitters' stores, a carpenter and joiner shop equipped with band and circular saws, a boring machine, a planer and sizer and an edger. Next to this are rooms for plumbers and pipe coverers, and finally a sheet metal workshop. On the shore side of these buildings are storage spaces for the fittings and supplies belonging to the various departments.

The largest single power requirement in the yard is at the shipways, where seven air compressing plants use about 4,500 horsepower. The next largest power requirement is for operating the derricks at the shipways. The necessity for illuminating the ships and yard so that night shifts can work most efficiently and also to assist the guards in patroling the yard at night makes it necessary to furnish current equivalent to 1,500 horsepower for lighting purposes, or enough light for a city of 12,000 people. A heating plant is provided for heating the administration building, restaurant, template shop and hospital, all other buildings remaining unheated.

Entire Project Originated by Submarine Boat Corporation

It is to the Submarine Boat Corporation that credit is due not only for the original conception of this project but also for the design of the entire plant and of the ships they are to build. The layout of the plant, number of shipways, location of the buildings, etc., are original with the Submarine Boat Corporation. Since February 1, the yard has been under the personal direction of Rear Admiral F. T. Bowles, assistant general manager of the Fleet Corporation.

The construction of the plant has been carried out by the Submarine Boat Corporation under the supervision of H. C. Higgins, authorized representative, and G. A. Duncan, resident engineer for the Shipping Board. The officers of the Submarine Boat Corporation are: H. R. Carse, president; H. R. Sutphen, L. Y. Spear and G. C. Davidson, vice-presidents; T. C. Dawson, secretary and treasurer; F. E. Kirby, consulting engineer. At the Newark Bay shipyard the department managers are: B. L. Worden, general manager; George T. Horton, assistant general manager; G. A. Anthony, supervising engineer; C. T. Henderson, chief engineer; J. J. Scollan, manager hull construction, and J. P. Nicholas, purchasing agent.

Fig. 1.—Laying Keel at Shipway No. 3, Bristol Plant

Shipping Board's Bristol Plant

Shipyard and Industrial Town Built for Government at Bristol, Pa., by Merchants Shipbuilding Corporation

AT Bristol, Pa., where the third large Government fabricated steel ship building yard is located, the work of transforming an old manufacturing site and adjacent farm lands into a fully equipped shipyard, adequate for turning out sixty 9,000 ton cargo ships in eighteen months and a new industrial town for housing a population of 6,000, all within the short space of four months, marks an achievement remarkable not only as an engineering feat but also as an example of true American enterprise and ingenuity in meeting an emergency.

Here the work is being carried out for the United States Shipping Board Emergency Fleet Corporation by the Merchants Shipbuilding Corporation, of New York and Philadelphia, headed by R. H. M. Robinson, a former naval constructor, and controlled by W. Averell Harriman, son of the former railroad magnate. The site comprises about 600 acres, divided up into the shipyard itself, which has a waterfront of about 4,900 feet along the Delaware River and extends back about 1,500 feet from the river, and an industrial town site about 2,400 feet long and 1,200 feet wide, located between the shipyard and the main line of the Pennsylvania railway, which parallels the river.

9,500 Men to be Employed

Preliminary work in the construction of the plant began on September 7, 1917, and on February 20 the plant was practically completed. Keels have been laid on several of the ways and as soon as shipbuilding operations are in full swing a maximum of 9,500 men will be employed in the yard. On a single eight-hour shift about 6,500 men will be required; but as much of the work will be done in two shifts, with overtime keeping the plant in operation practically twenty-four hours a day, provision must be made for over 9,000 workers.

Satisfactory Progress

That such satisfactory progress has been made in the construction of this plant against unusual difficulties is attributed to the foresight and ability exercised by the Merchants Shipbuilding Corporation in so planning and coördinating the work that each part of the gigantic undertaking was brought to completion at the same time, thus providing a complete shipbuilding plant in working order before the actual operations of shipbuilding were begun. Under the leadership of the parent organization, the construction work was divided up and sub-let to separate contracting firms, each of which, with its own working staff and organization, was especially fitted and equipped to carry out efficiently the particular work assigned to it. Thus each part of the plant, as a unit, was rapidly pushed to completion without interference or delay from the other work.

The original contract for ships to be built at this plant called for forty single screw cargo vessels of 9,000 tons

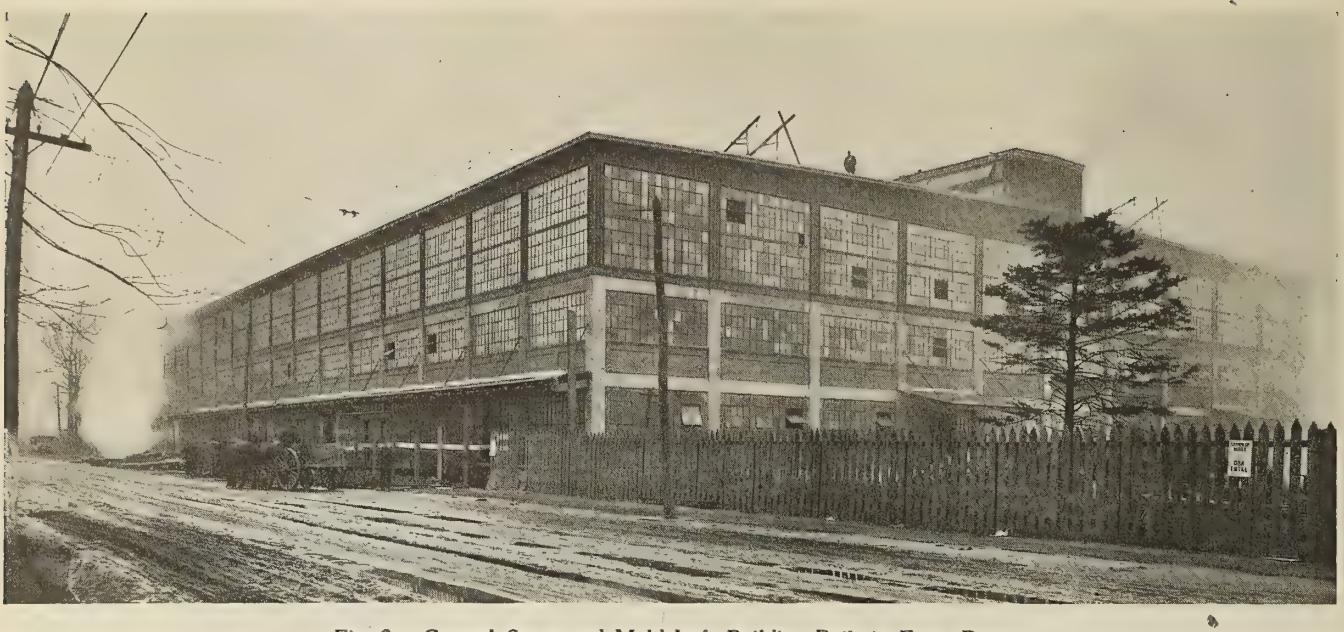


Fig. 2.—General Stores and Mold Loft Building Built in Forty Days

deadweight carrying capacity, each 401 feet long, 54 feet beam and 32 feet depth, fitted with geared turbine propelling machinery and watertube boilers of 3,000 horsepower, designed to give the vessels a sea speed of about 11 knots. Later, the contract was increased by the addition of twenty more vessels of the same size. From 12 to 20 percent of the hull work will be fabricated at the yard, while the remainder will be fabricated in the bridge and structural shops outside. It is estimated that the vessels will be about four months on the ways and one month at the fitting out berth.

The plant is divided into four yards, comprising the storage yards for fabricated and unfinished material, the building ways, shops and service buildings. Twelve shipways are provided in groups of four each. The ways are 484 feet long, spaced for the most part 108 feet between centers. At the water end they are supported for a length of about 174 feet up to high water level on wooden piles, the tide here being about 5 feet 9 inches. On shore the ways are of concrete construction throughout, the foundations consisting of concrete piles, from 15 to 35 feet long, capped with reinforced concrete cross beams. The declivity of the ways is 9/16 inch to the foot.

Shipways and Cranes

Between each set of ways is a steel crane runway, each runway carrying two traveling boom cranes for conveying the material onto the ways, as it is brought from the storage yards or fabricating shops to the head of the ways. Five of the runways, designed by Terry and Tench, are supported on triangular steel towers, footing on individual concrete bases resting on piles. The towers are

Fig. 3.—Plate and Furnace Shops

Fig. 4.—Typical Buildings in New Industrial Town

thoroughly braced both crosswise and longitudinally with struts. The other seven runways, are supported on square steel towers footing on spread concrete foundations and thoroughly braced.

The traveling boom cranes for these runways are of two types. The cranes used on nine of the runways have a capacity of 15 tons at a reach of 54 feet and 5 tons at 92 feet. The other cranes have a capacity of 16 tons at a reach of 54 feet.

At the shore end of each runway a building is provided for tools, paint, toilets and the transformers.

Storage Yards

Fabricated ship steel from outside shops is first brought on spur tracks from the main line of the Pennsylvania railroad to the main storage yard, located inshore from the shipways and beyond the plate and furnace shops, for sorting and distribution. Four railroad tracks in this yard are served by three A-frame gantry cranes, two of 10 tons capacity and one of 15 tons.

From the main storage yard, tracks lead to the head of the shipways, to the furnace and plate shops and to the fitting out yard. Along one side of the plate shop the tracks are served by two 10-ton A-frame gantry cranes.

At the fitting out wharf, which is located downstream from the shipways and which is of sufficient length for fitting out three vessels simultaneously, the river is being dredged to a depth of 20 feet. On a 30-foot gage track running along the water edge of the wharf is a 60-ton gantry crane, which, with the lighter locomotive cranes, will convey materials and equipment on board the vessels after launching.

Old Buildings Utilized

As the shipyard is erected on the site of the Standard Cast Iron Pipe and Foundry Company, which was purchased by the Merchants Shipbuilding Corporation less than a year ago, the buildings already standing, which are of substantial steel and brick construction, have been used so far as possible to house various departments of the shipbuilding company. The new buildings required have been made of permanent construction with steel or combined reinforced concrete and steel frames. The whole plant, in fact, including the shipways and shops, has been laid out and designed by the Merchants Shipbuilding Corporation, with a view to its permanent use as a modern, up to date shipbuilding establishment, irrespective of the present emergency needs.

In the old buildings have been located the main plate and furnace shops, the pipe, sheet metal and riggers' shop, the machine shop and boiler and blacksmith shops. The general stores and mold loft are housed in a new three-story building of reinforced concrete and steel frame construction, 300 by 200 feet, built complete in forty days, a record of which the contractors may justly feel proud. The shipwrights' shop and joiner shop are also new steel frame buildings, located near the fitting out wharf. Adjoining the buildings a paint shop and pipe storage building is provided.

The plate and furnace shops are in one building about

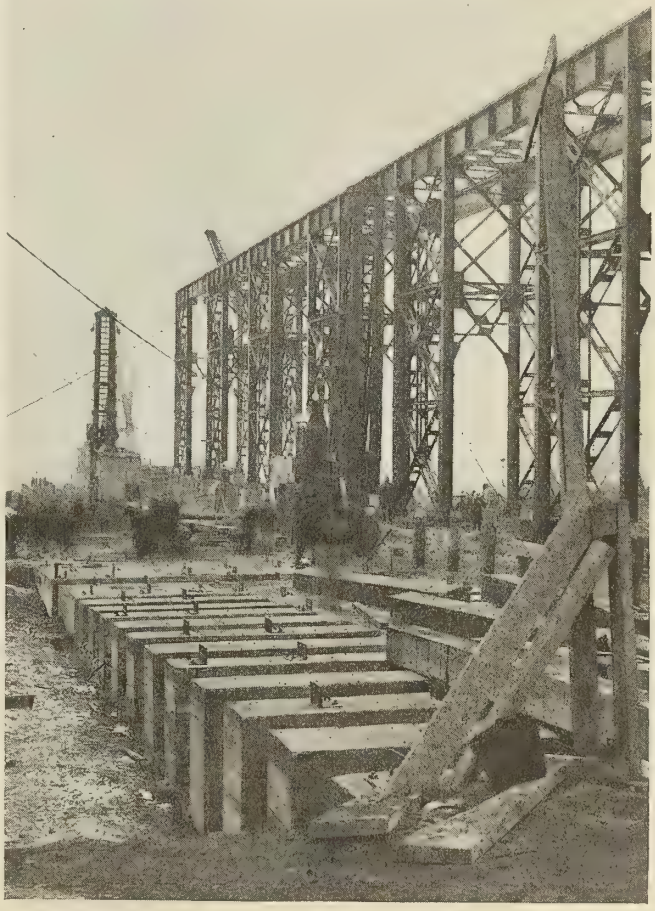


Fig. 5.—Showing Permanent Character of Concrete Foundation for Shipways

1,000 feet long and 102 feet 10 inches wide, made continuous by joining together two of the old buildings and rearranging the interior to accommodate the installation of the necessary machinery for the progressive handling and fabricating of ship steel. The plate shop itself is 459 feet 4 inches long, divided into two aisles 47 feet and 55 feet 10 inches wide respectively. It is of steel frame construction with brick and corrugated iron sides.

Equipment of Plate Shops

At one end of the plate shop is a laying out space with ten benches, each 27 by 6 feet. Opposite the laying out space, in the smaller aisle, is a set of mangling rolls. Adjacent to the laying out space in the larger aisle are six 48-inch punches, equipped with Lysholm spacing tables, while opposite in the smaller aisle are two 36-inch punches and a gate shear of the same make. Beyond the gate shear is a code punch, a manhole punch and rotary shear, and three 36-inch punches. At the extreme end of the shop is the tool room, next to which is a radial countersinking machine.

In the larger aisle along the wall beyond the punches are two 30-foot plate planers and three radial countersinking machines. Opposite the countersinking machines are a vertical shear, a plate punch, a scarphing machine and a set of 32-foot bending rolls.

Pipe and Riggers Shop

Another department housed in one of the old buildings is the pipe, sheet metal and riggers shop. This building is 182 feet 9 inches by 109 feet 6 inches, the floor space being divided up for sheet metal working, the electrical department, model and storage. The principal equipment here consists of pipe threading machines, all with direct motor drive. There are in all three 2-inch, two 4-inch, two 6-inch, one 8-inch and one 12-inch machines.

The equipment also includes four drill presses and a horizontal and a radial drill, a disk grinder and disk press, a metal band saw and an emery wheel grinder. The tool room is at one corner of the building.

Shipwrights and Joiner Shops

For the shipwrights' shop, a new steel frame building 165 feet and 6¾ inches by 87 feet 4 inches was put up, the building being completed on December 15. For equipment, the shop has a parallel swing saw, a No. 14 straight rip saw, band saw, single surfacer, planer, boring machine and two grinders.

The joiner and pattern shop, one of the largest of the new buildings at the fitting out wharf, is of steel frame construction 240 feet long by 75 feet wide. The tool room and office are on opposite corners at one end of the building. The machinery here includes a railway cut-off saw, single head tenoner, vertical hollow chisel mortiser, four-sided sticker, jointer, variety saw, universal saw and universal sandpaper machine. There are also two lathes and a swing cut-off table, a 36-inch band saw, a double spindle shaper and 48-inch triple drum sander, a parallel swing saw and a universal woodworking machine, grindstone, 12-inch circular saw, jointer, woodturning gap lathe, band saw and surface planer. The building was finished on November 29 and the machinery in by December 20.

In addition to the above named buildings there are at the main entrance to the yard the plant office building, the large administration building, time clock house, a garage, hospital and a large restaurant.

New Industrial Town Built

Not the least interesting feature of the work at the Bristol plant is the way in which the company is solving the problem presented by the lack of facilities for housing shipyard workmen in Bristol and neighboring towns. It was found necessary to provide homes for about 3,000 workmen and their families and for this purpose a new industrial town, adequate for housing a population of 6,000, is being erected on a site 2,400 by 1,200 feet, adjacent to the yard.

The town site is attractively laid out in city blocks with a playground and park in the center. The houses are arranged in groups comprising barracks for bachelor quarters with boarding houses or hotels at the ends of the blocks, apartment houses for small families, group houses for larger families, and finally 100 single houses for those who desire and can afford this mode of living. About 1,500 men can be accommodated in the barracks, 1,000 persons in the apartments, 1,500 in the group houses and 400 in the single houses. A central heating plant will take care of the barracks and those houses not provided with furnaces. Electric lighting will be supplied to every house and Bristol's water and sewage systems will be utilized.

The industrial houses as well as the new buildings in the shipyard were built by Fred T. Ley & Company, Inc., of New York and Springfield, Mass. The other contractors engaged in the building of the Bristol plant were as follows: John Monks & Sons, New York, shipways and craneway foundations, including outboard piling, also pier and bulkhead construction; William Gordon Corporation, New York and Philadelphia, installation of power plant equipment, machinery, pipe lines, electrical and mechanical equipment; Raymond Concrete Pile Company, concrete piling; Leverring & Garrigues, furnishing and erection of structural steel on buildings; American Dredging Company, dredging; Alphons Custodis Company, labor. The plant was built under the supervision of Robert E. Kline, plant engineer of the Emergency Fleet Corporation, and under the direction of W. H. Mason, superintendent of construction of the Merchants Shipbuilding Corporation.

When wood alcohol is to be used to any extent, have the room very well ventilated, as it affects the eyes and even produces blindness.

In experimental work it is not wise to make two changes at the same time, as, if the result is satisfactory or unsatisfactory, the reason for either is still obscure.

Area and surface are not synonymous, and sometimes men mix them up as did the man who corrugated a piston, thinking that in so doing he was increasing area and making his engine more powerful.

The continuous rotary motion of the turbine is ideal for certain drives, but the crank is still the ideal drive for an air compressor, as it gives the mechanical advantage of power application just when it is needed.

It is very advisable to have more than one way of getting out of a boiler or engine room, even if one of them is not very handy.

It is astonishing to see how few engineers understand how a steam steering engine works. He can tell you perhaps why it starts but he does not know why it stops.

Buy Liberty Bonds.

Builders of the Emergency Fleet

THE United States Shipping Board Emergency Fleet Corporation has made public a list of the shipbuilders engaged in building vessels for the new American merchant marine. This list comprises 133 yards, 58 of which are building steel vessels, 69 wooden vessels, 5 composite vessels, and one concrete ships.

A summary of the classification is given in the following table:

Location of Shipyards	Builders of Steel Vessels	Builders of Wood Vessels	Builders of Composite Vessels	Builders of Concrete Vessels	Builders of Requisitioned Vessels (steel)
Atlantic Coast	18	44	4	1	15
Pacific Coast	11	24	1	0	7
Great Lakes	2	1	0	0	5
Totals	31	69	5	1	27

The complete list of the companies engaged in building merchant vessels, giving the location of the offices and works, is as follows:

Builders of Steel Vessels

American International Corporation, 140 North Broad street, Philadelphia, Pa. (Works, Hog Island, Philadelphia, Pa.)

The Atlantic Corporation, 77 Franklin Street, Boston, Mass. (Works, Porthsmouth, N. H.)

The American Shipbuilding Company, Cleveland, Ohio.

American Shipbuilding Corporation, Alexandria, Va.

Baltimore Dry Dock & Shipbuilding Company, Baltimore, Md.

Bayles Shipyard (Inc.), 115 Broadway, New York. (Works, Port Jefferson, L. I.)

California Shipbuilding Company, Long Beach, Cal.

Columbia River Shipbuilding Corporation, Portland Ore.

Downey Shipbuilding Corporation, 120 Broadway, New York. (Works, Richmond Borough, New York.)

Daniels, Oscar, Company, Woolworth Building, New York. (Works, Tampa, Fla.)

Erickson Engineering Company, Hanover National Bank Building, New York. (Works, Seattle, Wash.)

Federal Shipbuilding Company, 54 Dey street, New York. (Works, Hackensack River, N. J.)

Groton Iron Works, 50 Broad street, New York. (Works, Groton, Conn.)

Hampton Roads Shipbuilding & Dry Dock Corporation, Norfolk, Va.

Jahncke Shipbuilding Company, 814 Howard avenue, New Orleans, La.

Los Angeles Shipbuilding & Dry Dock Company, Los Angeles, Cal.

Merrill-Stevens Shipbuilding Corporation, Jacksonville, Fla.

Moore & Scott Iron Works, San Francisco, Cal. (Works, Oakland, Cal.)

Merchant Shipbuilding Corporation, 165 Broadway, New York. (Works, Bristol, Pa.)

Newburgh Shipyards, Newburgh, N. Y.

Northwest Steel Company, Portland, Ore.

Patterson-McDonald Shipbuilding Company, Seattle, Wash.

Pacific Coast Shipbuilding Company, First National Bank Building, San Francisco, Cal. (Works, Suisun Bay, San Francisco.)

Pensacola Shipbuilding Company, 155 North Clark street, Chicago, Ill. (Works, Pensacola, Fla.)

Skinner & Eddy Corporation, Seattle, Wash.

Seattle Construction & Dry Dock Company, Seattle, Wash.

Southern Shipbuilding Corporation, Charleston, S. C.

Sun Shipbuilding Company, 1428 South Penn Square, Philadelphia, Pa. (Works, Chester, Pa.)

Saginaw Shipbuilding Company, Saginaw, Mich.

Submarine Boat Corporation, 5 Nassau street, New York. (Works, Newark, N. J.)

Western Pipe & Steel Company of California, San Francisco, Cal.

Builders of Wood Vessels

Alabama Dry Dock & Shipbuilding Company, Mobile, Ala.

American Shipbuilding Company, 11 Broadway, New York. (Works, Brunswick, Ga.)

Beaumont Shipbuilding & Dry Dock Company, Beaumont, Tex.

Barbare Brothers, Tacoma, Wash.

Venicia Shipbuilding Corporation, 131 Loidesdorff street, San Francisco, Cal. (Works, Benicia, Cal.)

Coast Shipbuilding Company, 504 Concord Building, Portland, Ore.

Cumberland Shipbuilding Company, Portland, Maine. (Works, South Portland, Maine.)

Coos Bay Shipbuilding Company, Marshfield, Ore.

Chandler, R. J., Los Angeles, Cal. (Works, Wilmington, Los Angeles, Cal.)

Dantzler Shipbuilding & Dry Dock Company, Moss Point, Miss.

Dierks-Blodgett Shipbuilding Company, care of Dierks Lumber & Coal Company, Kansas City, Mo. (Works, Pascagoula, Miss.)

Feeney & Bremer Company, Tillamook, Ore.

The Foundation Company, Woolworth Building, New York. (Works, Passaic River, N. J.)

Fulton Shipbuilding Company, Los Angeles, Cal. (Works, Wilmington, Cal.)

Freeport Shipbuilding Company, Freeport, Me. (Works, South Freeport, Me.)

Grays Harbor M. S. Corporation, Aberdeen, Wash. (Works, Grays Harbor, Wash.)

Groton Iron Works, 50 Broad street, New York. (Works, Noank, Conn.)

Grant-Smith-Porter-Guthrie Company, St. Johns, Portland, Ore.

Gildersleeve Ship Construction Company, Gildersleeve, Conn.

Geo. A. Gilchrist, Thomaston, Me.

Hillyer-Sperring-Dunn Company, Jacksonville, Fla.

Hammond Lumber Company, San Francisco, Cal. (Works, Humboldt Bay, Cal.)

Hodge Ship Company, Moss Point, Miss.

Housatonic Shipbuilding Company, Stratford, Conn.

Heldenfels Brothers, Beeville, Tex. (Works, near Port Aransas, Tex.)

Jahnecke Shipbuilding Company, New Orleans, La. (Works, Tchefuncta River, La.)

Johnson Shipyards Corporation, Mariners' Harbor, Staten Island, N. Y.

Kingston Shipbuilding Company, Kingston, N. Y.

Kruse & Banks Shipbuilding Company, North Bend, Ore.

The Kelly-Spear Company, Bath, Me.

Lake & Ocean Navigation Company, 208 South La Salle street, Chicago, Ill. (Works, Sturgeon Bay, Wis.)

Lone Star Shipbuilding Company, 111 Broadway, New York. (Works, Beaumont, Tex.)

Maryland Shipbuilding Company, Lexington Building, Baltimore, Md. (Works, Soller's Point, Md.)

McBride & Law, Beaumont, Tex.

J. N. McCammon, Houston, Tex. (Works, Beaumont, Tex.)

Murnan Shipbuilding Corporation, Commercial Trust Building, Philadelphia, Pa. (Works, Pinto Island, Mobile, Ala.)
Midland Bridge Company, Houston, Tex.
J. M. Murdock, Jacksonville, Fla.
Morey & Thomas, Box 619, Jacksonville, Fla. (Works, St. Johns River, Jacksonville, Fla.)
Meacham & Babcock Shipbuilding Company, Seattle, Wash. (Works, Salmon Bay, Wash.)
McEachern Ship Co., Portland, Ore. (Works, Astoria, Ore.)
Newcomb Lifeboat Company, Hampton, Va.
National Shipbuilding Company, 120 Broadway, New York. (Works, Orange, Tex.)
North Carolina Shipbuilding Company, Morehead City, N. C.
Nilson & Kelez Shipbuilding Corporation, Seattle, Wash.
Peninsula Shipbuilding Company, Portland, Ore.
Portland Ship Ceiling Company, Portland, Me.
Potomac Shipbuilding Company, Colorado Building, Washington. (Works, Quantico, Va.)
Rodgers, Geo. F., & Company, Astoria, Ore.
G. M. Standifer Construction Corporation, Portland, Ore.
Sloan Shipyards Corporation, Olympia, Wash.
Sanderson & Porter, 52 William street, New York. (Works, Willapa Harbor, Wash.)
Ship Construction & Trading Company, 50 Broadway, New York. (Works, Stonington, Conn.)
Henry Smith & Sons Company, Baltimore, Md.
Southern Dry Dock & Shipbuilding Company, Orange, Tex.
L. H. Shattuck, Manchester, N. H. (Works, Portsmouth, N. H.)
Sommarstrom Shipbuilding Company, care of Maj. C. L. Tilden, 217 Front street, San Francisco, Cal. (Works, Columbia City, Ore.)
Seaborn Shipyards Company, Seattle, Wash. (Works, Tacoma, Wash.)
St. Helens Shipbuilding Company, San Francisco, Cal. (Works, St. Helens, Ore.)
Sandy Point Shipbuilding Corporation, Sandy Point, Me.
Tacoma Shipbuilding Company, Tacoma, Wash.
Traylor Shipbuilding Corporation, Cornwells Heights, Pa.
Tampa Dock Company, Tampa, Fla.
Universal Shipbuilding Company, National Bank Building, Houston, Tex. (Works, Houston Ship Canal, Harris County, Tex.)
Union Bridge & Construction Company, Morgan City, La.
U. S. Maritime Corporation, Union Savings Bank Building, Washington. (Works, Brunswick, Ga.)
Wilson Shipbuilding Company, Astoria, Ore.
Wright's Shipyards, Tacoma, Wash.
York River Shipbuilding Corporation, West Point, Va.

Builders of Composite Vessels

Mobile Shipbuilding Company, Mobile, Ala.
Kelly Atkinson Construction Company, Security Building, Chicago, Ill. (Works, Mobile, Ala.)
Merrill-Stevens Company, Jacksonville, Fla.
Supple & Ballin, Portland, Ore.
Terry Shipbuilding Corporation, Savanna, Ga.

Builders of Concrete Vessels

Liberty Shipbuilding Company, 515 State street, Boston, Mass.

Yards Building Requisitioned Ships

Albina Engine & Machine Works, Portland, Ore.
Ames Shipbuilding & Dry Dock Company, Seattle, Wash.
Cramp, William & Sons; Ship & Engine Building Company, Philadelphia, Pa.
Chester Shipbuilding Company, Finance Building, Philadelphia, Pa. (Works, Chester, Pa.)
Craig Shipbuilding Company, Long Beach, Cal.
Duthie, J. F., & Company, Seattle, Wash.
Fore River Shipbuilding Corporation, Quincy, Mass.
Great Lakes Engineering Works, Detroit, Mich.
Globe Shipbuilding Company, Superior, Wis.
Hanlon Dry Dock & Shipbuilding Company, Oakland, Cal.
Harlan & Hollingsworth Corporation, Wilmington, Del.
Manitowoc Shipbuilding Company, Manitowoc, Wis.
Moore, Samuel L., & Sons, Corporation, Elizabeth, N. J.
McDougall-Duluth Company, Duluth, Minn.
Newport News Shipbuilding & Dry Dock Company, Newport News, Va.
New York Shipbuilding Corporation, Camden, N. J.
New Jersey Shipbuilding Company, Land Title Building, Philadelphia, Pa. (Works, Gloucester, N. J.)
Pennsylvania Shipbuilding Company, Land Title Building, Philadelphia, Pa. (Works, Gloucester, N. J.)
Pusey & Jones Company, Wilmington, Del.
Standard Shipbuilding Company, 44 Whitehall street, New York.
Staten Island Shipbuilding Company, Port Richmond, N. Y.
Texas Steamship Company, Bath, Me.
Toledo Shipbuilding Company, Toledo, Ohio.
Tampa Shipbuilding Company, Tampa, Fla.
Union Iron Works, San Francisco, Cal.
Willamette Iron & Steel Works & Northwest Steel Company, Portland, Ore.
Bethlehem Steel Corporation, South Bethlehem, Pa. (Works, Sparrows Point, Md.; Quincy, Mass.; Wilmington, Del.; Elizabeth, N. J.; San Francisco, Cal.)

How to Make a Stud Setter

BY W. D. FORBES

Stud setters save time. It is exasperating to see a man screw down a stud and then caliper its height by trying to peek over the end of it.

How do you make a stud setter? Cut off a piece of tool steel to a length of about 2½ diameters of the stud that you are going to set. This may be either square or hexagonal, measuring across the flats a ¼ inch more than the diameter of the stud. Anneal this piece and drill and tap it straight through, tapping it as free as possible.

Take a flat pointed set screw of the diameter of the stud, and screw on to it a semi-finished nut until it comes up against the head of the screw. Have this set screw project from the nut into the tapped square hexagon, so that it will allow a stud to be screwed into it 1½ diameters before fetching up. This set screw is of course hardened.

Screw the set screw down until the nut stops on the tapped piece, start the stud to be set as usual and screw the stud setter on to it. When the top of the stud comes against the end of the set screw, a wrench can be used to screw down as far as required. By loosening up the set screw, the setter can be easily unscrewed.

How, it may be asked, will this give an even height of stud? Without something else being used, it will not, and that something else should be a piece of ordinary pipe of the size which will allow it to be slipped over the stud loosely and of a depth which, added to the length of the stud in the stud setter, will give the proper height of the stud. Coming down on this piece of pipe, if the set screw has been brought down to the nut again, will do the trick.

Vessels Requisitioned or Under Contract for United States Shipping Board

Classified List of Ships Under Construction for the Emergency Fleet, Showing Number, Type and Tonnage

THE United States Shipping Board authorizes publication of the following table showing the number, type and tonnage of the vessels which have been requisitioned or are under contract for construction in new or old established American shipyards for the American merchant marine:

NUMBER, TYPE, AND DEADWEIGHT TONNAGE OF VESSELS UNDER CONTRACT OR REQUISITIONED BY THE EMERGENCY FLEET CORPORATION, SEGREGATED AS TO WOOD, STEEL, COMPOSITE, AND CONCRETE.

TYPE OF VESSELS.	VESSELS UNDER CONTRACT.									
	Total.		Wood.		Steel.		Composite.		Concrete.	
	No. of Vessels.	Deadweight Tonnage.	No. of Vessels.	Deadweight Tonnage.	No. of Vessels.	Deadweight Tonnage.	No. of Vessels.	Deadweight Tonnage.	No. of Vessels.	Deadweight Tonnage.
Cargo:										
2,500	1	2,500	1	2,500	....	.....	....	.....	....	.....
3,000	1	3,000	....	.....	....	.....	....	.....	1	3,000
3,500	457	1,599,500	381	1,333,500	24	84,000	50	175,000	2	7,000
4,000 and under	37	147,650	29	115,650	....	.....	8	32,000	....	.....
4,500 and under	6	27,000	6	27,000	....	.....	....	.....	....	.....
4,700	12	56,400	12	56,400	....	.....	....	.....	....	.....
5,000 and under	220	1,022,700	....	.....	220	1,022,700	....	.....	....	.....
6,000 and under	13	74,100	....	.....	13	74,100	....	.....	....	.....
7,500 and under	76	569,600	....	.....	76	569,600	....	.....	....	.....
8,800 and under	98	862,400	....	.....	98	862,400	....	.....	....	.....
9,000	80	720,000	....	.....	80	720,000	....	.....	....	.....
10,000 and under	86	814,800	....	.....	86	814,800	....	.....	....	.....
12,000 and under	16	170,900	....	.....	16	170,900	....	.....	....	.....
Total	1,103	6,070,550	429	1,535,050	613	4,318,500	58	207,000	3	10,000
Cargo and transports:										
8,000	70	560,000	....	.....	70	560,000	....	.....	....	.....
10,000	5	50,000	....	.....	5	50,000	....	.....	....	.....
Total	75	610,000	....	.....	75	610,000	....	.....	....	.....
Tankers:										
7,500	3	22,500	....	.....	3	22,500	....	.....	3	.....
10,000 and under	9	87,300	....	.....	9	87,300	....	.....	....	.....
10,100	15	151,500	....	.....	15	151,500	....	.....	....	.....
Total	27	261,300	....	.....	27	261,300	....	.....	....	.....
Tug boats	20	.....	14	.....	6	.....	....	.....	....	.....
Grand total	1,225	6,941,850	443	1,535,050	721	5,189,800	58	207,000	3	10,000
Grand total requisitioned and under contract	1,557	9,260,017	443	1,535,050	1,053	7,507,967	58	207,000	3	10,000

TYPE OF VESSELS.	VESSELS UNDER REQUISITION.			
	Total.		Steel.	
	No. of Vessels.	Deadweight Tonnage.	No. of Vessels.	Deadweight Tonnage.
Colliers:				
5,000 and under	3	14,700	3	14,700
9,000 and under	4	34,400	4	34,400
Total	7	49,100	7	49,100
Passenger and cargo:				
5,000 and under	4	18,972	4	18,972
6,000 and under	2	10,600	2	10,600
Total	6	29,572	6	29,572
Tankers:				
5,000 and under	2	8,900	2	8,900
7,500 and under	7	49,300	7	49,300
8,800 and under	3	24,880	3	24,880
9,000 and under	7	63,000	7	63,000
10,000 and under	12	115,400	12	115,400
12,500 and under	15	161,295	15	161,295
12,650 and under	1	12,650	1	12,650
Total	47	435,425	47	435,425
Cargo:				
3,500 and under	82	267,280	82	267,280
5,000 and under	35	155,100	35	155,100
6,000 and under	2	11,000	2	11,000
7,500 and under	29	212,500	29	212,500
8,000 and under	2	16,000	2	16,000
8,800 and under	48	420,200	48	420,200
9,000 and under	14	126,000	14	126,000
10,000 and under	19	184,840	19	184,840
12,500 and under	24	286,450	24	286,450
15,000 and under	2	28,000	2	28,000
Total	257	1,707,370	257	1,707,370
Refrigerators:				
7,500 and under	12	77,700	12	77,700
10,000 and under	1	10,000	1	10,000
Total	13	87,700	13	87,700
Transports:				
5,000 and under	2	9,000	2	9,000
Grand total	332	2,318,167	332	2,318,167

REQUISITIONED VESSELS COMPLETED AND ACCEPTED OR RECONVEYED.

TYPE OF VESSELS.	Number of Vessels.	Deadweight Tonnage.
Colliers:		
8,600 tons	1	8,600
12,650 tons	1	12,650
Total	2	21,250
Ore carriers:		
6,000 tons	1	6,000
11,300 tons	4	45,200
17,060 tons	1	17,060
Total	6	68,260
Passenger and cargo:		
4,986 tons	1	4,986
Tankers:		
5,000 tons	1	5,000
8,500 tons and under	2	16,630
9,000 tons	2	18,000
Tankers—Continued.		
10,475 tons and under	4	41,725
14,900 tons and under	5	72,150
Total	14	153,505
Cargo:		
3,500 tons and under	26	82,520
4,500 tons and under	7	28,700
6,000 tons and under	4	22,500
7,500 tons and under	8	57,960
8,800 tons and under	14	123,200
10,000 tons and under	7	67,860
12,500 tons	3	37,500
13,000 tons	1	13,000
Total	70	433,240
Grand total	93	681,241

VESSELS CONTRACTED FOR AND REQUISITIONED.

CHARACTER OF VESSELS.	Number of Vessels.	Total Deadweight Capacity.
Wood	443	1,535,050
Steel	*723	5,207,400
Composite	58	207,000
Concrete	3	10,000
Total contracted	1,227	6,959,450
Total requisitioned (all steel)	†425	2,999,408
Grand total	1,652	9,958,858

*This total includes 2 vessels of 8,800 tons each, completed and accepted. †This total includes 93 vessels of 681,241 tons which have been completed and accepted or reconveyed to original owner. Prepared by the statistical department in the executive and administrative division. March 12, 1918.

Safety and Relief Valves

Discussion of Construction and Operation of Safety and Relief Valves for Marine Work

BY M. W. LINK*

SAFEGUARDING the various pressure vessels and lines in any power plant is a necessity. The various kinds of fluids, i. e., steam, air, hot water, cold water, oil, mixtures of steam and water and exhaust steam should be treated as an individual problem, so as to obtain the best results from the safety and relief valve. One type of safety valve is not adaptable to all of the above services.

First—Because steam and air are expansive fluids.

Second—Because water and oil cannot be treated as expansive fluids.

Huddling or Pop Chamber

The most important feature in any safety valve is the design of the disk and its huddling chamber.

Broadly speaking, a safety valve for an expansive fluid should have an adjustable pop or huddling chamber located between the valve seat and the atmosphere. Its fundamental principle is to give the valve a popping action; that is, when the valve relieves, the escaping steam is temporarily confined in this chamber before escaping to the atmosphere. This temporary confinement increases the upward load against the spring, thereby causing the disk to lift higher; and after a predetermined drop in pressure in the boiler, the valve closes with a slight snap.

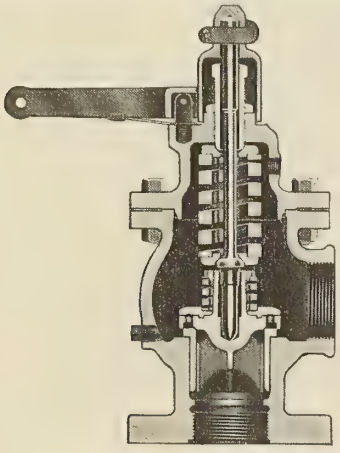


Fig. 1.—Valve with Inside Spring

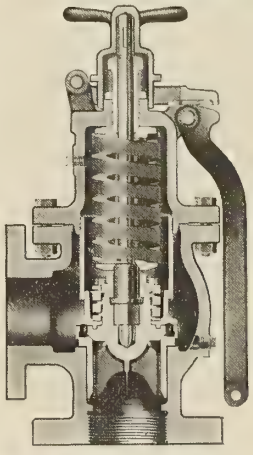


Fig. 2.—Valve with Inside Spring Encased

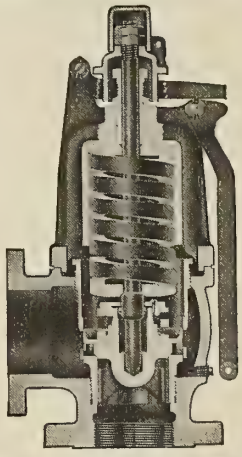


Fig. 3.—Valve with Outside Spring

The adjustable huddling chamber should be so designed that it is concentric with the disk in any position. The adjustable arrangement should be preferably located so as to be free from corrosion, scale, etc.

Safety or relief valves for cold liquids, oil, water, etc., do not require a huddling chamber of the same type as a steam pop valve, the energy of the moving liquid being utilized to assist the valve in lifting, and helps in reducing the drop in pressure before closure.

Many types of water relief valves do not have any huddling chamber, and, owing to their simplicity, are to be preferred to the more complex types. This type of valve loses considerable pressure before closing.

Safety valves for a mixture of steam and water—i. e., snifting and cylinder relief valves—require a different form of huddling chamber than one for steam or cold liquids. Usually, when these valves are called upon to act they must give quick, instant relief and handle a considerable volume of steam and water mixed.

Relief valves for hot water present a further problem. For pressures up to about 75 pounds one type of huddling chamber has been found to give best results. For pressures above 75 pounds an adjustable huddling chamber along lines of a steam pop valve will give best results.

In overhauling a steam pop valve the user should familiarize himself with the basic features of the huddling chamber design. This will save endless testing and trouble.

After assembling the valve, the huddling chamber ring or mechanism should be set to give the smallest possible loss in pressure or blow-down. The adjustment should then be adjusted to give 4 to 5 pounds blow-down on pressures between 100 and 200 pounds, and 6 to 8 pounds on higher pressures. Reducing the blow-down below the amounts mentioned invariably reduces the discharging capacity of the valve, and in the long run is wasteful of steam.

Advocates of outside and inside springs on safety valves each have good reasons for their preference.

On steam pops, outside springs, generally speaking, are to be preferred. Springs exposed to the air remain cooler and are visible at all times. Some prefer inside springs because they are tamper-proof. Outside spring pops have a higher initial cost.

On compressed air pops, inside springs are as satisfactory as the outside type.

On water relief valves inside spring valves should be used wherever the *relieving and closing pressures are important* and must be maintained. Water relief valves with outside springs should be equipped with a stuffing box to prevent water from being thrown upward while the valve is discharging and overcome continual leakage if the valve outlet is piped to any line or vessel. Naturally, the tightness or friction created in the stuffing box will cause a variation in the action of the relief valve.

Cylinder relief valves should always have enclosed

* Assistant mechanical expert, Crane Company, Chicago, Ill.

springs, as their action must not be interfered with, by friction or otherwise.

Relief valves for ammonia machines should naturally be of the enclosed type to prevent the escape of fumes to the atmosphere, and valves should be "All Iron" or steel.

Springs

Springs should be designed for the service they are to be used on. The length and number of free coils should be such that there is never any danger of the spring being compressed solid while the valve is discharging under over-pressure conditions, or while the valve is being opened by hand while under pressure. Springs for steam and hot water service should be capable of being compressed solid and should return to within .02 or .03 inch of their original length after compression.

The pitch diameter of the coils, if five times the diameter of the stock, is considered good proportions for steam pop valves. Extremely long springs have no particular advantage when used on safety valves. They look good on a drawing, but do not help the efficiency of a pop valve. After the valve has been set, any spring having sufficient clearance between the coils to allow a further compression equal to 10 percent of the diameter of the valve seat is long enough to give the best service, providing the pitch diameter is right.

Steel springs for steam should be drawn at a temperature of about 500 degrees F., and if possible 100 degrees higher. Before being used, the ends should be ground absolutely square with the center line of the spring. The writer conducted a series of tests upon springs not properly ground, and found the smooth action and clean-cut operation of a perfect safety valve was entirely ruined by springs ground 1/16 inch off square. The valves tested had swivel washers on both ends of the springs, but still the unequal downward thrust on the washer was evidenced in the action of the valve.

When overhauling a pop valve the spring should be thoroughly examined and ground square on the ends, removing any corrosion, etc. The spring washers should also be thoroughly cleaned, and all corrosion, scale and foreign matter removed.

Stems for Valves

Single-piece stems have been found to give the best service. Pop valves for steam, air, high pressure water should have a single stem extending from the disk to the outside of the valve bonnet.

Stems for steam pop valves should be of steel. While subject to corrosion, they do not wear at the point and are less subject to bending and crystallization. Brass stems are to be preferred on water relief valves because of their non-corrosive qualities. For marine use, manganese bronze will be found satisfactory.

One of the principal causes of erratic action in steam pop valves is bent stems. Any misalinement of the spring and any friction on the stem will cause a large blow-down and possibly a change in the popping pressure. The point of the stem in contact with the disk should be the rounded apex of a cone, which will give the best results in tightness, uniform popping and wear.

When overhauling a pop valve see that the stem is straight and the seating point is perfect. If battered or worn, dress it up.

Location of Seating Point on Stem

The design of the popping or huddling chamber governs the location of the end of the stem in the disk. It has been found that locating the end of the stem below the bearing on the seat a distance equal to one-quarter the diameter of the valve gives good results on many types of valves, although some types with the end of the stem above the seat bearing are giving good results. This is particularly true of flat seat safety valves. On water relief valves there is not much choice where the end of the stem meets the disk, although the lower the stem the longer the valve seems to keep tight in service.

Guiding Disk to Seat

Practically every successful make of safety and relief valve employs some type of integral guide which assists the disk in finding its seat. The multiple wing or feather guide is in the majority. Experience has proven this to be the best type of guide, suffering less from rapid wear than the single round or center guide. Some valves have three wings. The majority of types have four, and some have five. Service tests prove the five-swing guide superior for high pressure, high capacity steam pop valves.

Center pin guides are the most successful for use on oil, exhaust steam and water containing a large amount of scale-forming solids.

A good practice on steam valves is to have .01-inch clearance between the guides and bore of the valve bushing. Water and oil valves may have more clearance.

The bore of the valve bushing and the wing guides on the disk must have an absolutely smooth finish. "Any old kind" of finish is detrimental to the perfect operation of the valve, causing chattering, rapid wear and leakage.

In overhauling a pop or relief valve after having been in service, the guides and bore should be thoroughly cleaned and smooth. The smoother the better.

Relieving Capacity

The relieving capacity of safety valves, in pounds of steam, cubic feet of air and gallons of water per hour is a feature that has in the past not received the prominence it deserves.

It is a well-known fact that all pop safety valves of the same size but of different design do not have the same relieving capacity. This was illustrated by tests made by P. G. Darling, member A. S. M. E.; also by tests made by the writer, published in the *Valve World,* May, 1914.

The general results of both of these tests were the same; for instance, 4-inch pop safety valves of different designs at the same popping pressures, varied in relieving capacity 600 percent; that is, the lift of the disk varied from 3/100 inch to 18/100 inch. *The relieving capacity is directly proportional to the lift.*

This feature was recognized by the Master Mechanics' Association of the Railroads; also by the Boiler Code Committee of the A. S. M. E., in the formation of their National Boiler Code.

Water relief valves of the conventional type do not vary greatly in their relieving capacities, although some types, particularly those used on fire pumps, have very high capacities.

The Board of Supervising Inspectors recognize no fixed relieving capacities for safety valves.

Another important feature not universally known or taken advantage of is the enormous increase in relieving capacity due to a slight increase in overpressure while the valve is discharging. Presented below are two tables, Nos. 1 and 2, one showing the relieving capacity of pop safety valves on steam at the set pressure and at 3 percent overpressure. The lift of the disk at the set pressure 10/100 inch. The blow-down is 4 pounds below 200 pounds set pressure, 6 pounds above 200 pounds set pressure. The table on water relief valves is based on 10 percent over set pressure.

Broadside View of Concrete Ship *Faith* After Launching

TABLE No. 1.—STEAM, POUNDS DISCHARGED PER HOUR.

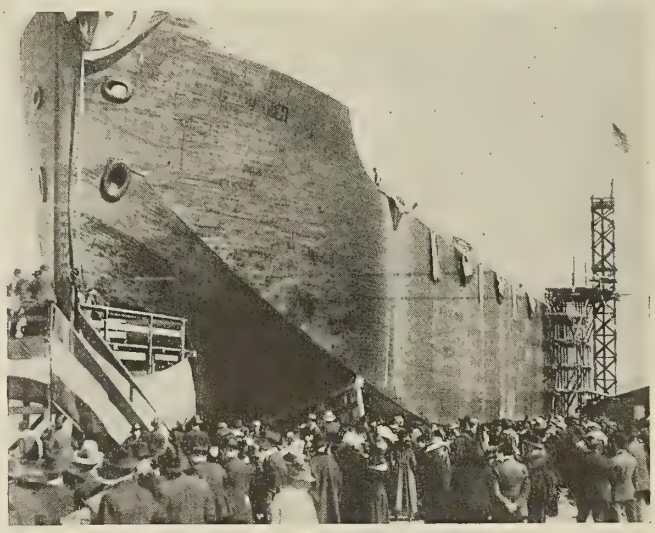
Size.		Boiler Pressures.				
		50 Pounds	100 Pounds	150 Pounds	200 Pounds	250 Pounds
1 inch	A	710	1,260	1,800	2,345	2,900
	B	850	1,510	2,160	2,815	3,480
1¼ inch	A	880	1,570	2,250	2,940	3,620
	B	1,055	1,885	2,700	3,425	4,345
1½ inch	A	1,060	1,885	2,710	3,530	4,350
	B	1,270	2,260	3,250	4,235	5,220
2 inch	A	1,420	2,510	3,595	4,710	5,800
	B	1,705	3,010	4,305	5,650	6,850
2½ inch	A	1,770	3,145	4,510	5,885	7,255
	B	2,125	3,775	5,410	7,060	8,705
3 inch	A	2,130	3,775	5,420	7,065	8,700
	B	2,550	4,530	6,500	8,480	10,440
3½ inch	A	2,480	4,400	6,325	8,240	10,160
	B	2,975	5,280	7,590	9,885	12,190
4 inch	A	2,840	5,030	7,230	9,420	11,610
	B	3,405	5,600	8,630	11,300	13,930
4½ inch	A	3,190	5,660	8,130	10,595	13,060
	B	3,820	6,790	9,750	12,705	15,670

A Represents capacity at set pressure.
B Represents capacity at 3 percent over pressure.

TABLE No. 2—GALLONS DISCHARGED PER MINUTE FROM COMMERCIAL WATER RELIEF VALVES AT 10 PERCENT OVER PRESSURE.
Sizes ¾ to 2 inches—BRASS. 2½ inches to 4½ inches—IRON BODY.

Size.	Set Pressures.							
	25 Pounds	50 Pounds	75 Pounds	100 Pounds	125 Pounds	150 Pounds	175 Pounds	200 Pounds
¾ inch	3.8	5.2	6.5	7.5	8.5	9.5	11	13
1 inch	5	7.5	9.5	11	13	15	18	21
1¼ inch	7	9.5	13	15	17	20	23	27
1½ inch	9	13	16	18	21	25	29	34
2 inch	13	17	21	25	30	35	40	48
2½ inch	50	68	86	100	116	140	160	195
3 inch	60	80	100	122	142	170	195	240
3½ inch	70	95	120	145	170	200	230	280
4 inch	80	100	135	165	195	225	265	320
4½ inch	95	125	155	185	220	255	295	360

In determining the proper size safety or relief valve to be used on any service it is well to use as small a valve as possible and take advantage of the increase in relieving



Bow View of S. S. *Faith*

capacity due to any slight over-pressure which may occur. This reduces initial cost, repair bills and increases the life of the valve.

The smaller the valve the easier it is to keep it tight and the smaller the waste of steam, water or air.

(*To be concluded.*)

Launching of 5,000-Ton, Deadweight, Reinforced Concrete Ship *Faith*, at Redwood City, Cal., on March 14.
(For description see page 64, Marine Engineering, February, 1918)

Fig. 1.—Mold Loft, 500 Feet Long, in Second Story of Laying Out Building

Shipyard of the Sun Shipbuilding Company

Splendidly Arranged and Equipped Plant at Chester, Pa., for Building Standard Types of Oil Tankers and Steel Cargo Vessels

As a subsidiary of the Sun Company, Philadelphia, which has an oil pipe line terminus at Sabine Pass, Texas, and a refinery at Marcus Hook, Pa., and which maintains for the transportation of its products a fleet of ocean-going tankers with a combined tonnage of over 80,000, equivalent to a carrying capacity of 25,000,000 gallons of oil, the Sun Shipbuilding Company was formed about two years ago, for the purpose of building standard types of oil tankers and cargo vessels. The site chosen for the shipyard was on the Delaware river, at Chester, Pa., not far from the Sun Company's refinery. As the shipyard was designed to build only hulls and boilers, the extensive plant of the Robert Wetherill Company, engine builders at Chester, was purchased for the construction of engines and other machinery for the ships.

Sun Tanker Adopted as Standard

Specializing in the design and construction of standard types of oil tank and cargo vessels, the Sun Shipbuilding Company has spared no effort in producing economically the very best vessels that could be designed and built for the purpose. That the company has been eminently successful, although the yard has been in operation little more than a year, and its first vessel was launched last October, is shown by the fact that the company's design for a 10,000 ton deadweight oil tank steamship has been adopted by the United States Shipping Board as a standard.

The yard has a frontage of over 1,600 feet on the Delaware river, and extends back from the river about 1,500 feet, where the property is bounded by a branch of the Pennsylvania railroad.

General Arrangement of Plant

The plant is designed for a capacity of turning out 12 vessels a year and has five shipways, suitable for accommodating vessels up to 12,000 or 15,000 tons deadweight capacity. As shown by the plan of the yard, Fig. 9, at the head of the shipways are the main fabricating shops, back of which is the main storage yard. At one side of the shipways, and about 500 feet distant, is a wet dock, 200 feet wide by 600 feet long, which serves as a fitting out basis. At the head of the wet dock are the fitting out shops and general storehouse, and in back of that the boiler shop and blacksmith and light sheet metal-working shops.

The layout of the yard is such that as the material is received from the Pennsylvania railroad tracks at the inshore side of the property, it logically progresses from the storage yards through the laying out, fabricating and assembling shops to the head of the ways, where it is incorporated in the vessels under construction on the ways or goes through the fitting out shops to the wet dock and is there installed on the vessels after launching.

From the Pennsylvania tracks, a ladder of seven tracks runs through the plate and shape storage yard and into

Fig. 2.—Interior of Plate Shop, Showing Punches, Spacing Tables and Roller Skids

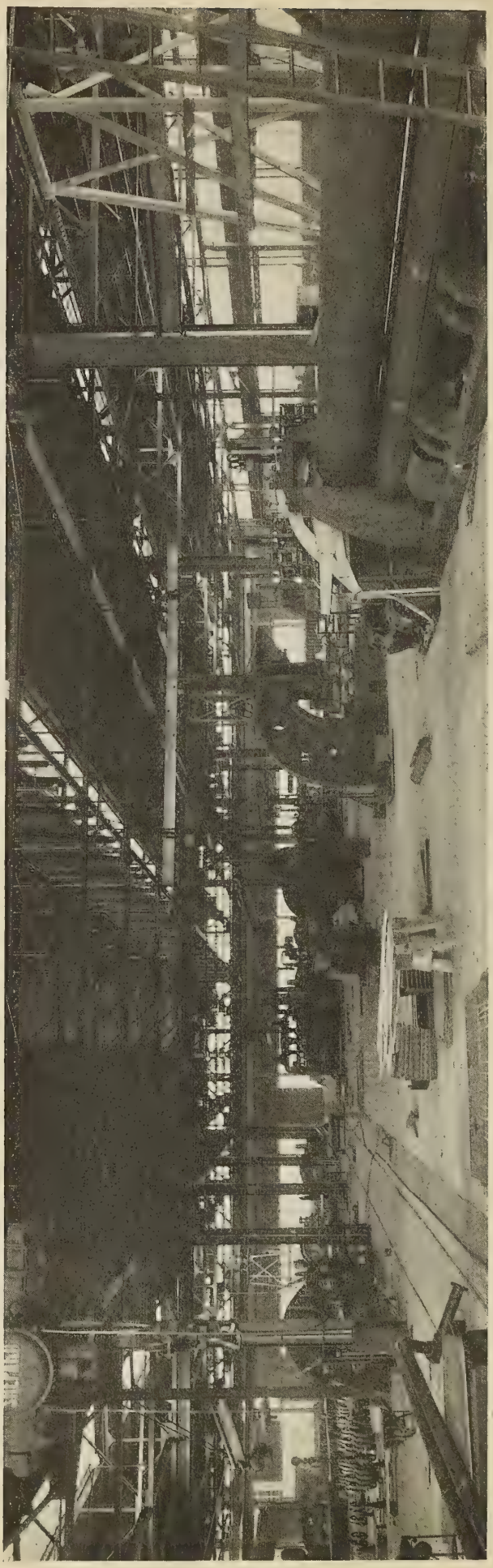


Fig. 3.—South End of Main Fabricating Shop. Five-ton Shepard Mono-rail Hoists Aid in Movement of Material Across the Shop

SHIPYARD OF THE SUN SHIPBUILDING COMPANY, CHESTER, PA.

Designed for Construction of Standard Type Oil Tankers and Cargo Vessels; Capacity, Twelve Ships a Year

Fig. 4.—General View of Sun Shipyard from Waterfront. Main Entrance and Office Building at the Left; Outfitting Shops, General Stores, Boiler Shop and Heating Plant in Center; Shipways and Fabricating Shops at the Right

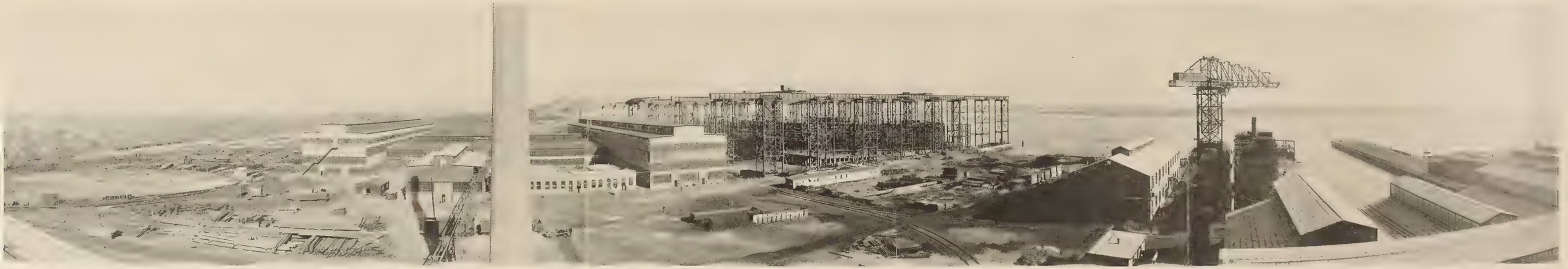


Fig. 5.—View of Sun Shipyard from Top of Boiler Shop. Storage Yard at the Left; Fabricating Shops and Shipways in Center; Fitting Out Berth at the Right

Fig. 6.—Plate Storage Yard, Showing Locomotive Cranes

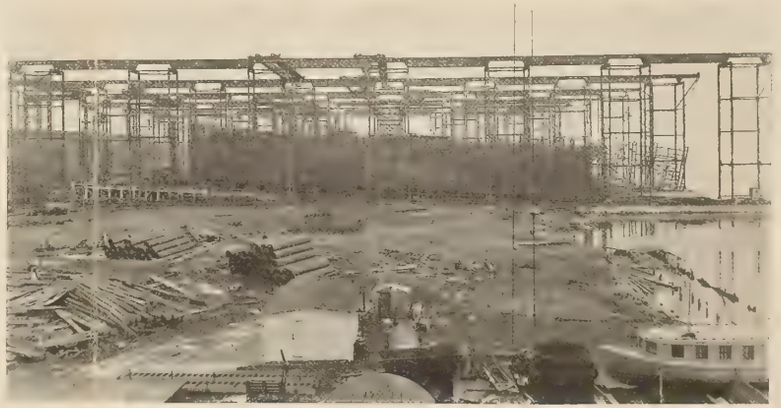


Fig. 7.—Shipways Built of Concrete and Served by Overhead Electric Traveling Cranes

Fig. 8.—Fitting Out Docks, Served by 120-Ton McMyler Hammerhead Crane

the laying out shop. In the yard, material is handled by locomotive cranes, but in the laying out and fabricating shops the material is handled on roller skids or by overhead electric cranes and hoists.

Over the laying out shop, which is 500 feet long by 80 feet wide, is the mold loft. At one end of the laying out shop is a set of Hilles & Jones straightening rolls, while in the center is a Williams, White & Company multiple punch. Two overhead Pawling & Harnischfeger electric traveling cranes of 5 tons capacity each traverse the length of this shop. At the far end of the shop is the hull smith shop, equipped with 30 forge fires, two oil furnaces, a Nazel hammer and Beaudry hammer.

Main Hull Fabricating Shop

Between the laying out and assembling buildings, but forming an integral unit with them, is the main fabricating shop for the ship plates and shapes. Here the arrangement of the machinery is such that the material, after being laid out, advances progressively through the different processes of punching, shearing, rolling, bending scarfing and straightening, until it arrives at the assembling shop, at the head of the ways, ready for riveting or immediate installation on the vessels under construction.

The fabricating shop is 230 feet wide by 300 feet long. At the upper end are four single-ended and three double-ended punches, all of Hilles & Jones make, equipped with

Fig. 10.—Main Office Building

Lysholm spacing tables, and also the plate and angle furnaces supplied by the American Shop Equipment Company. The plate furnace is 9 feet wide by 30 feet long and the angle furnace 4 feet wide by 52 feet long. At the bending blocks is a special flanging and beveling machine, designed and built at the Wetherill plant of the shipbuilding company. There is also, at the upper end

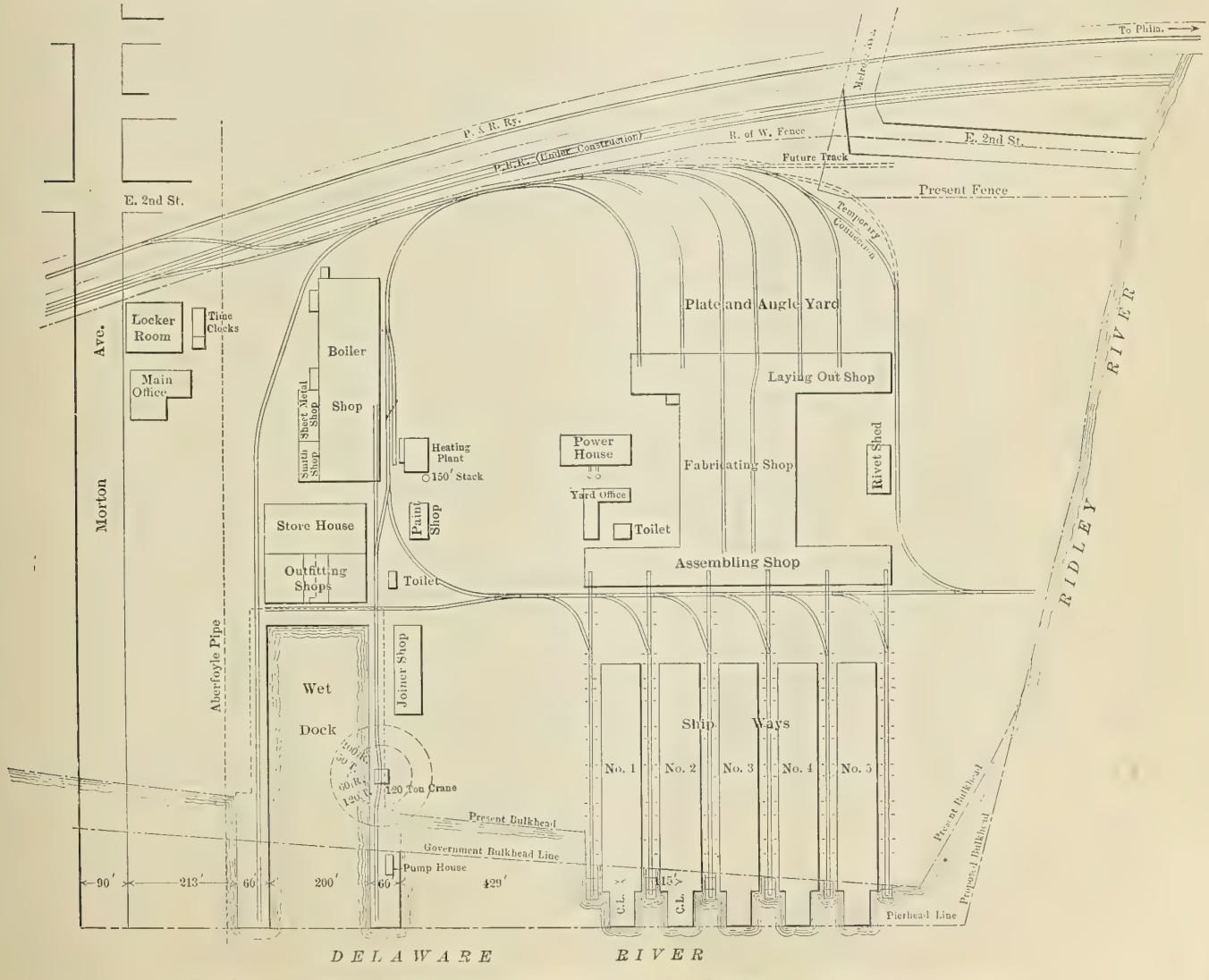


Fig. 9.—General Layout of the Yard, Showing Location of Buildings and Railroad Connections

Fig. 11.—Locker Building at Main Entrance

Fig. 12.—Interior of Employees' Locker Room

of the shop, a double angle shear and two single and one double-ended punches of the Hilles & Jones make, served with jib cranes. Alongside the bending slabs is an R. D. Wood joggler and along the east wall of the building, several rapid-action Hilles & Jones punches.

At the lower end of the fabricated shop are two Hilles & Jones 40-foot plate planers, a set of Hilles & Jones bending rolls, 37 feet long between housings, with the top roll 30 inches diameter and the bottom rolls 20 inches diameter, a set of straightening rolls, plate shears, man-

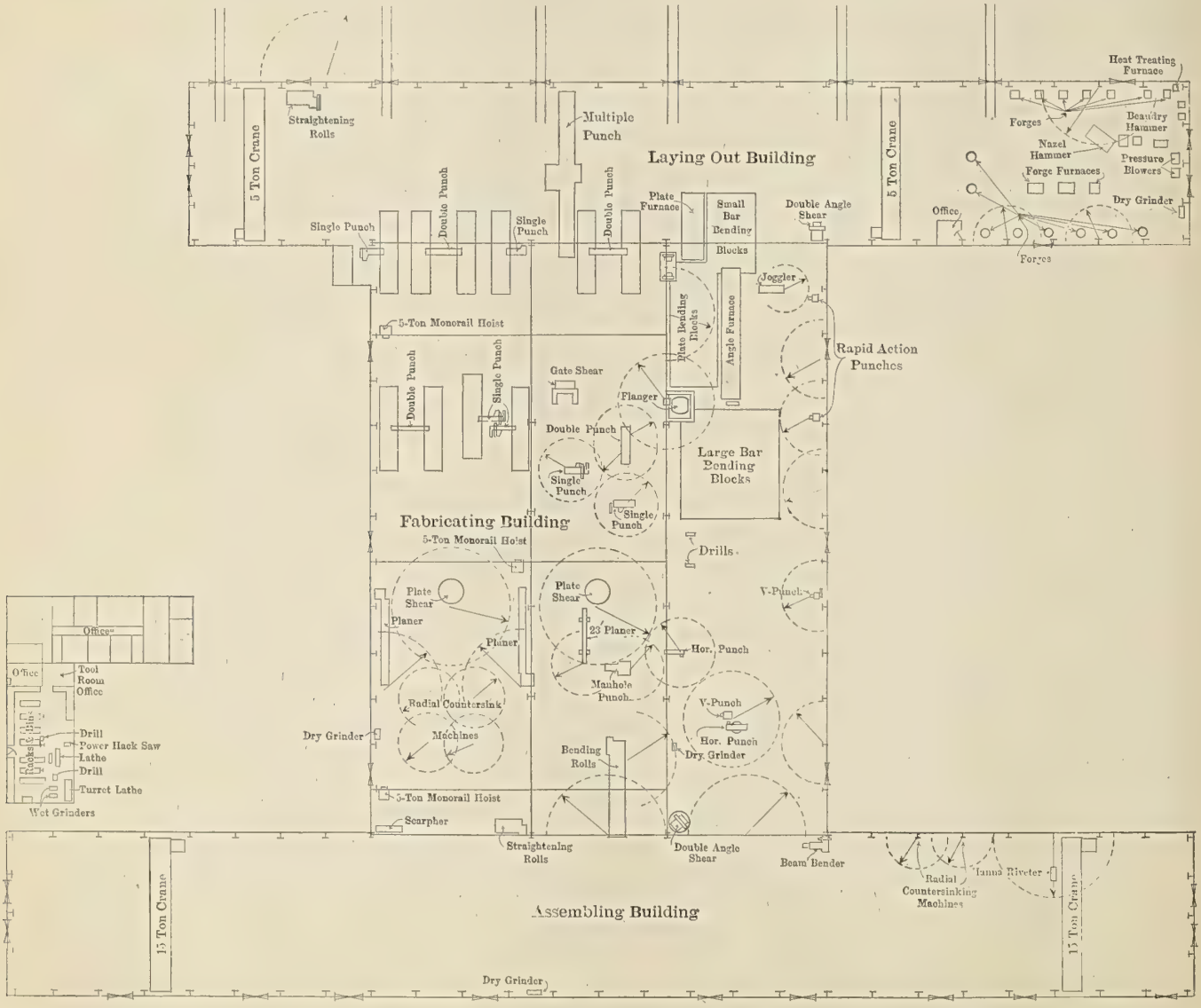


Fig. 13.—Plan of Main Fabricating Shops at Head of Shipways, Showing Location of Machinery

Fig. 14.—Wash Basins in Locker Room

hole punch and scarfing machine. The equipment also includes two horizontal and one vertical punch and four radial countersinking machines.

The assembling shop, which extends along the head of the shipways, and is joined to the fabricating shop, is 600 feet long by 80 feet wide, and is served by two overhead 15-ton Pawling & Harnischfeger traveling cranes. In the assembling shops, most of the operations are carried out with portable tools, such as pnuematic riveters and chipping hammers, and oxy-acetylene welding and cutting apparatus. At one end of the shop are a Hilles & Jones beam bender, two radial countersinking machines and a Hanna riveter.

Shipways

The shipways, of which there are five, are of reinforced concrete construction, 500 feet long by about 90 feet wide, spaced 115 feet between centers. The shipways are uncovered but are served by overhead electric traveling cranes, running on steel craneways, located between each shipway and extending up to the assembling shop. Over each shipway there is one 15-ton Pawling & Harnischfeger and one 10-ton Shaw crane.

Fig. 16.—120-Ton McMyler Hammerhead Crane at Fitting Out Dock

Fitting Out Berth

Downstream, about 500 feet from the shipways, is the wet dock, which is served by a hammerhead crane of 120 tons capacity at a 60-foot radius, built by the McMyler Interstate Company, Cleveland. Alongside the fitting out dock is a joiner and carpenter shop, and at the head of the dock, a pipe and coppersmith shop, equipment machine shop and riggers and electricians' workshop. The pipe and coppersmith shop is 75 feet by 90 feet. Its equipment includes 12-inch, 6-inch and 3-inch pipe threading and cutting machines, supplied by the Bignall & Keeler Machine Works, Edwardsville, Ill., a Lovekin tube expanding and

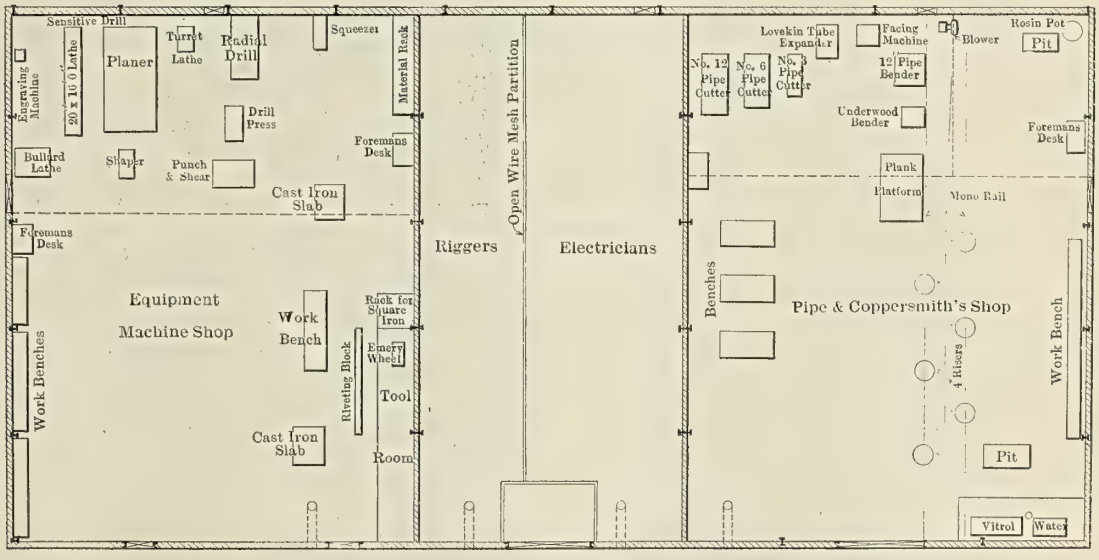


Fig. 15.—Plan of Fitting Out Shops at Head of Wet Dock

flanging machine; an R. D. Wood 35-ton hydraulic pipe bending machine and an Underwood pneumatic pipe bender, with a capacity for pipe up to 3-inch diameter.

The outfitting machine shop, which is used for making valves, flanges, ladders and other equipment for the vessels, is equipped with a Niles-Bement-Pond planer, 36 inches by 36 inches by 8 foot-travel; a Jones & Lamson turret lathe; a 24-inch Bullard vertical turret lathe; a 24-inch by 12-foot Lodge & Shipley lathe; two Hilles & Jones radial drills; two 5-foot Niles-Bement-Pond radial drills; a Shipley drill press and 24-inch Cincinnati drill press. There is also a Sellers combination punch and shear for use in making ladders and similar equipment; a Dallet horizontal drill press and a 30-ton hydraulic squeezer for bending angles, flat bars, etc., for floor plates and the like.

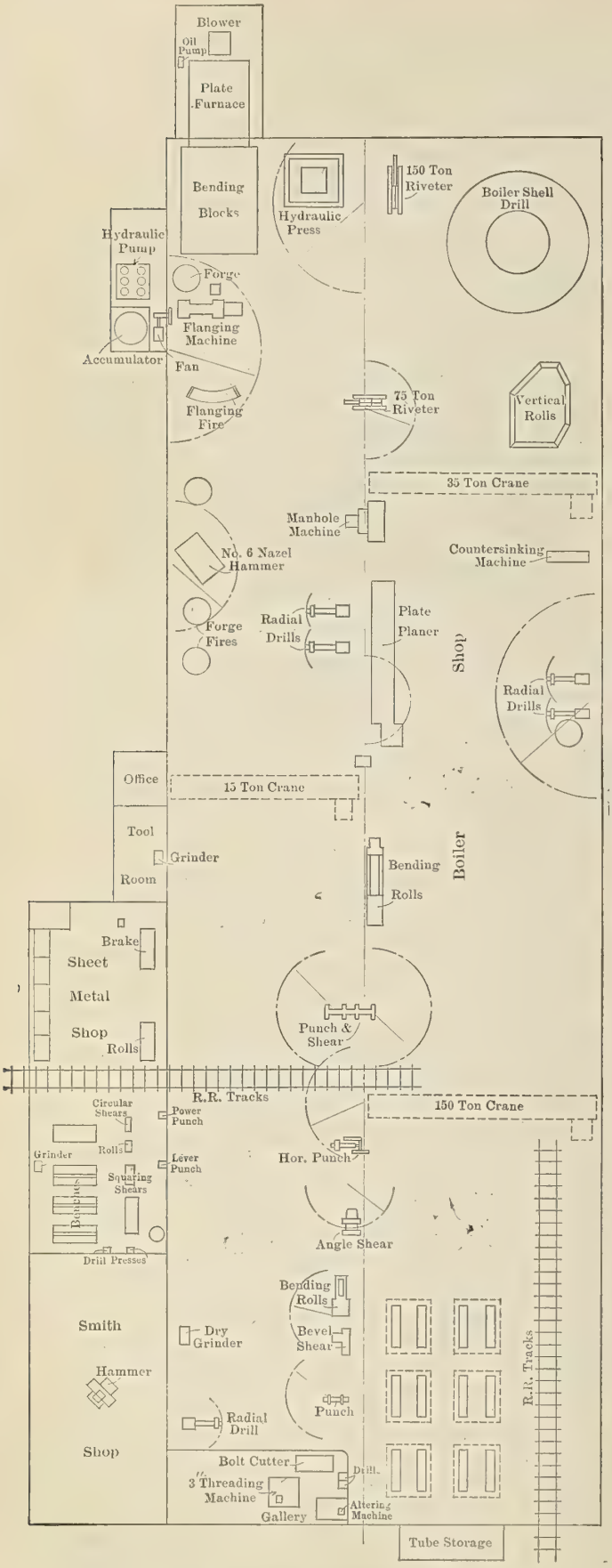


Fig. 17.—Plan of Boiler Shop

Adjoining the fitting out shops is the general storehouse, 200 feet long by 100 feet wide, on one side of which is a gallery partitioned off, so that the material and supplies for each contract being executed in the yard can be kept separate from the general stores. On the floor, heavy equipment, such as deck machinery, etc., is stored, and metal racks and bins are provided for copper, brass and iron piping, cold-rolled iron bars, plates, fittings and small equipment. Entrances to the storeroom are inclosed with wire partitions and separate entrances are provided to each of the adjoining fitting out shops.

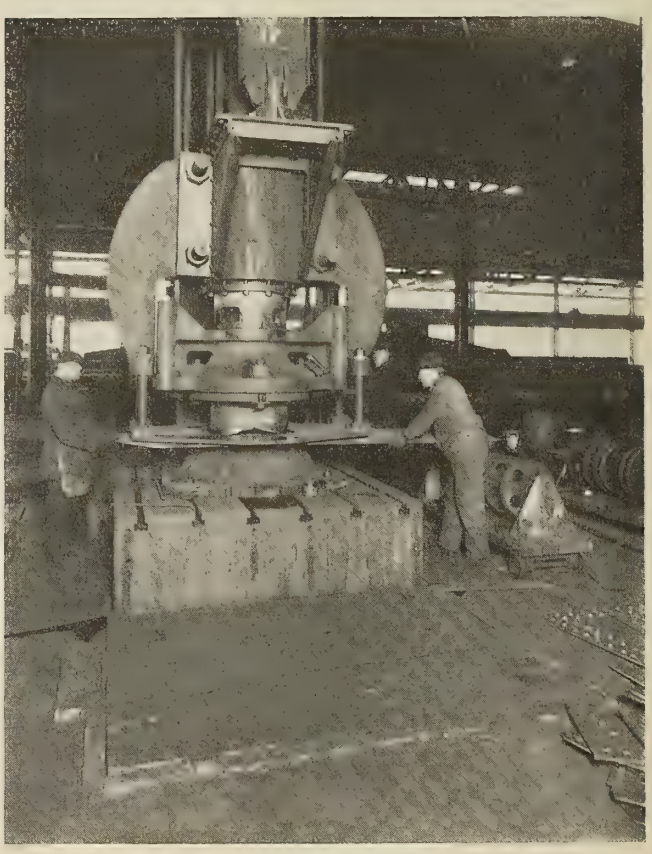


Fig. 18.—R. D. Wood Hydraulic Manhole Punch and Flanging Machine in Plate Shop

Boiler Shop

In the rear of the general storehouse is the boiler shop, 400 feet long by 120 feet wide. In the layout and equipment of the boiler shop, the various departments are so arranged and coördinated, that work can progress through the shop from the laying out of the plates to the testing of the finished boilers without delay or rehandling of materials from one end of the shop to the other. The material is received at one side of the shop in the center of the building, where it is laid out. Tack rivet holes are

Fig. 19.—150-Ton R. D. Wood Hydraulic Riveter in Boiler Shop; Gap, 14 Feet

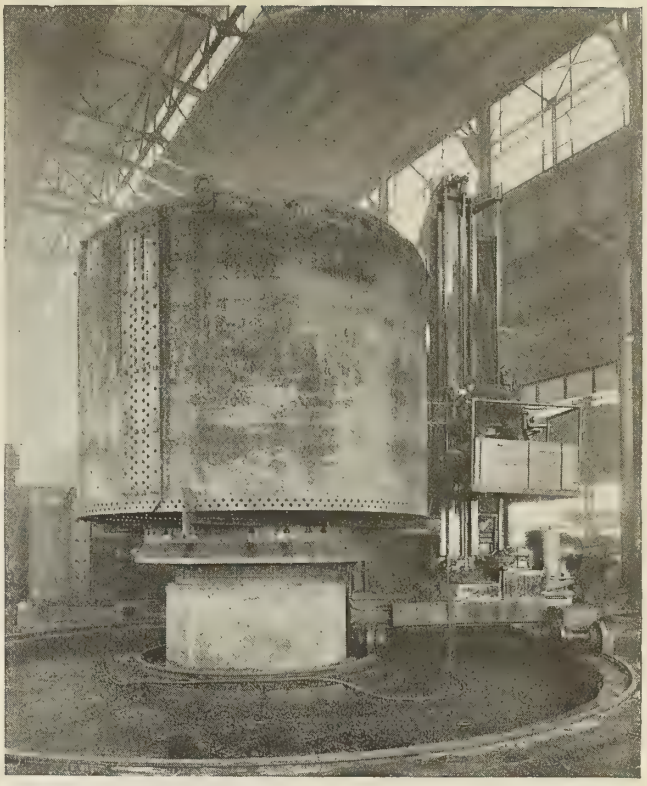


Fig. 21.—Three-Spindle Detrick & Harvey Boiler Shell Drill

drilled by radial drills next to the laying out space. Beside the radial drills is a Cleveland countersinking machine. The plates next go to a set of 14-foot vertical bending rolls, made by the Southwark Foundry & Machine Company, and pass from this to a three spindle boiler shell drill made by the Detrick & Harvey Machine Works of Baltimore. At the end of the shop is a 150-ton R. D. Wood hydraulic riveter with a 14-foot gap, alongside of which is a 100-ton hydraulic flanging press, built by the Wetherill Company. In the opposite corner of the shop is a 16-foot plate heating furnace, supplied by the American Equipment Company, and an R. D. Wood sectional flanging machine, together with forge and flanging fires and a Nazel hammer.

Fig. 20.—14-Foot Southwark Vertical Bending Rolls

Down the center of the shop there is a 75-ton 14-foot gap Niles-Bement-Pond hydraulic riveter and a manhole facing machine, also supplied by Niles-Bement-Pond Company. There is also a Hilles & Jones plate planer; a set of bending rolls and a combination Cleveland punch and shear. At the end of the large bay of the shop is the erecting and testing floor. At the corresponding end of the smaller bay are the lighter machine tools, including a horizontal punch, angle shear, small bending rolls and light punch, all supplied by Hilles & Jones; a Lennox beveling machine; a Landis machine for threading stay tubes and also a Landis triple machine for threading staybolts.

The boiler shop is divided into two bays, the larger bay being served by two Pawling & Harnischfeger overhead traveling cranes of 50 tons capacity each. For lifting the heaviest weights, such as finished boilers, these two cranes can be operated together, giving a lifting capacity of 100 tons. The smaller bay is served by one 15-ton and one 5-ton traveling crane of the same make.

Alongside the boiler shop is the light sheet metal shop, and blacksmith shop.

Power Plant

Power for the plant is taken from the Philadelphia Public Service Company, at 13,200 volts and transformed to 2,400 volts for use in the power house and 475 volts for the buildings. In the power house are two Ingersoll-

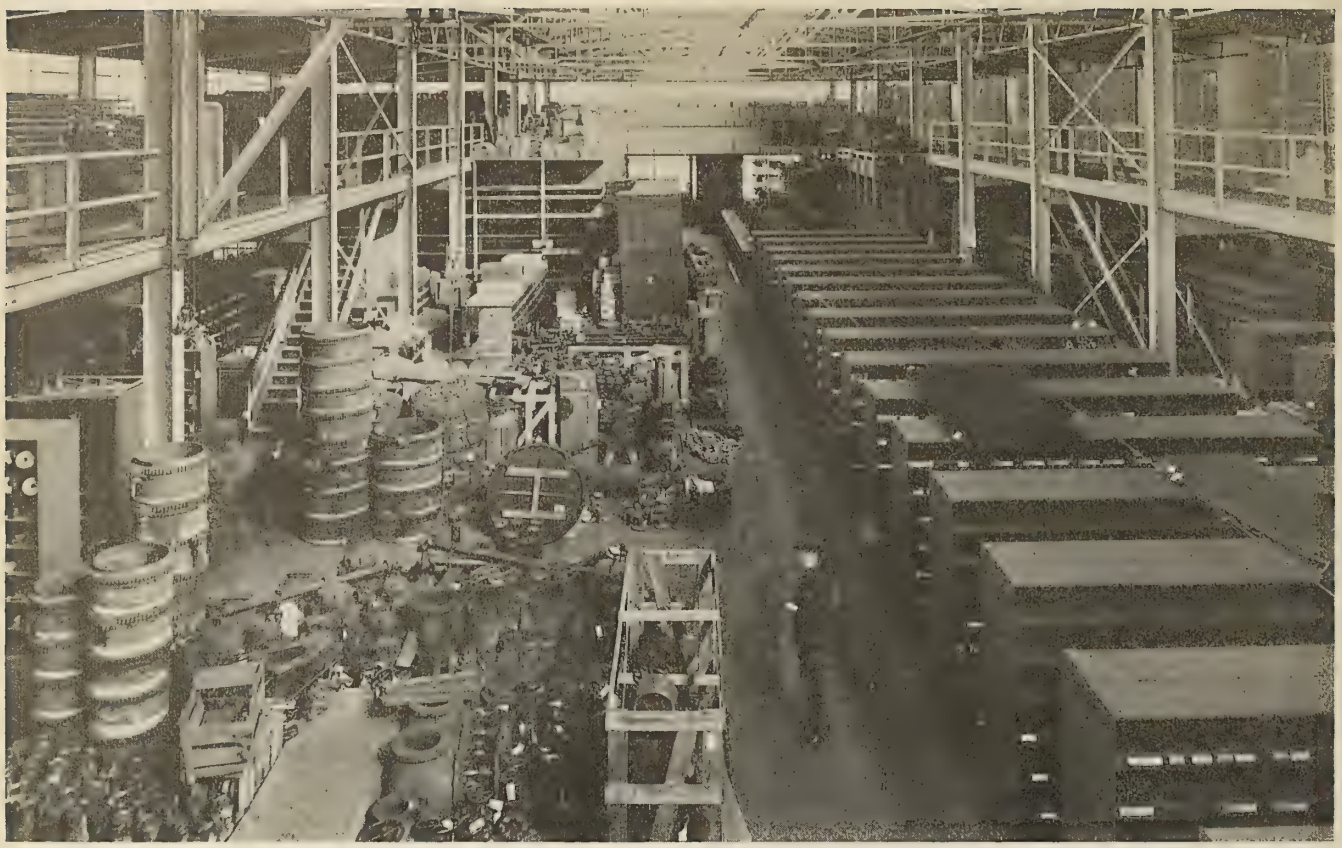


Fig. 22.—Interior of General Storehouse. Gallery at Right Partitioned Off into Compartments to Be Assigned to Each Vessel Under Construction

Fig. 23.—Interior View of Outfitting Machine Shop, Adjoining General Stores Building

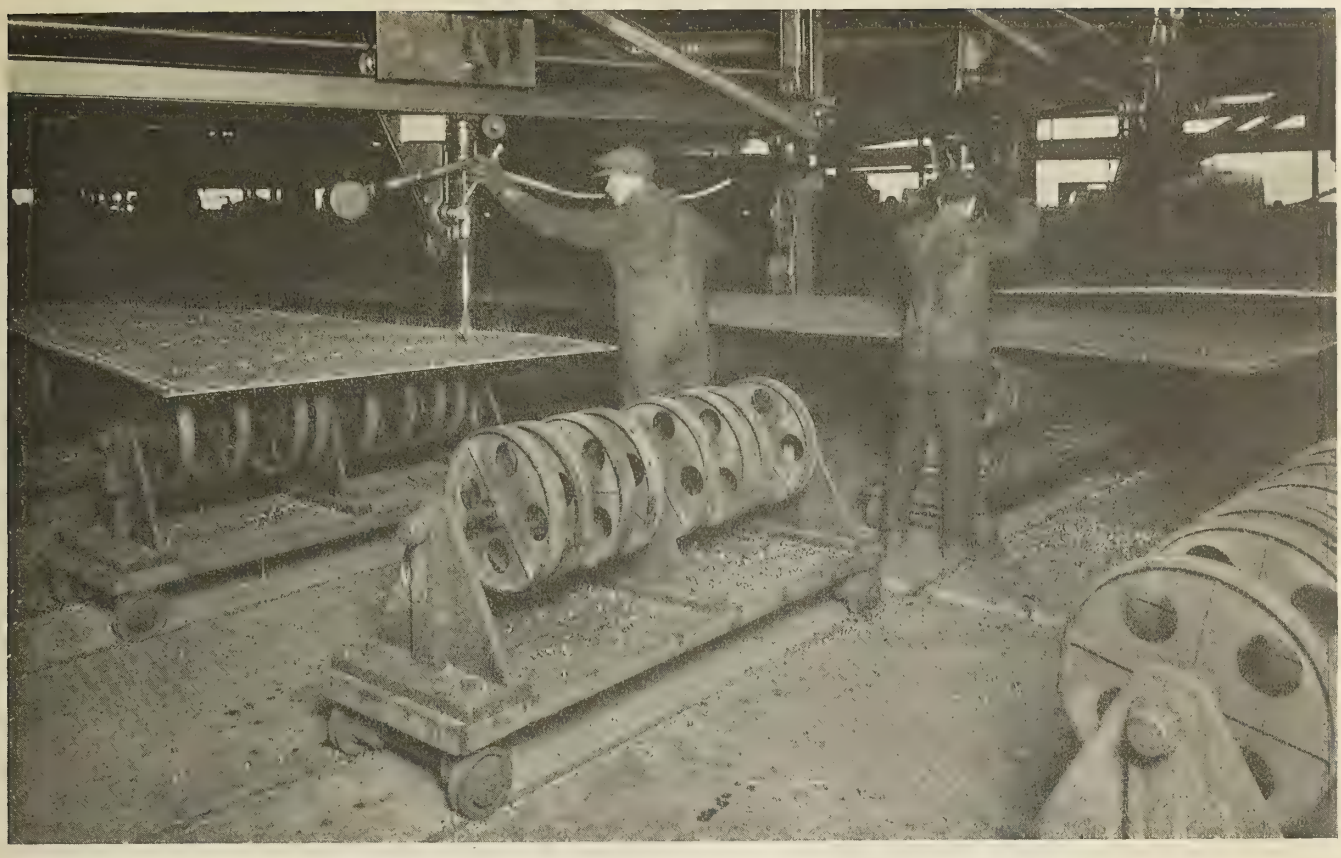


Fig. 24.—Radial Countersinking Machines in Plate Shop

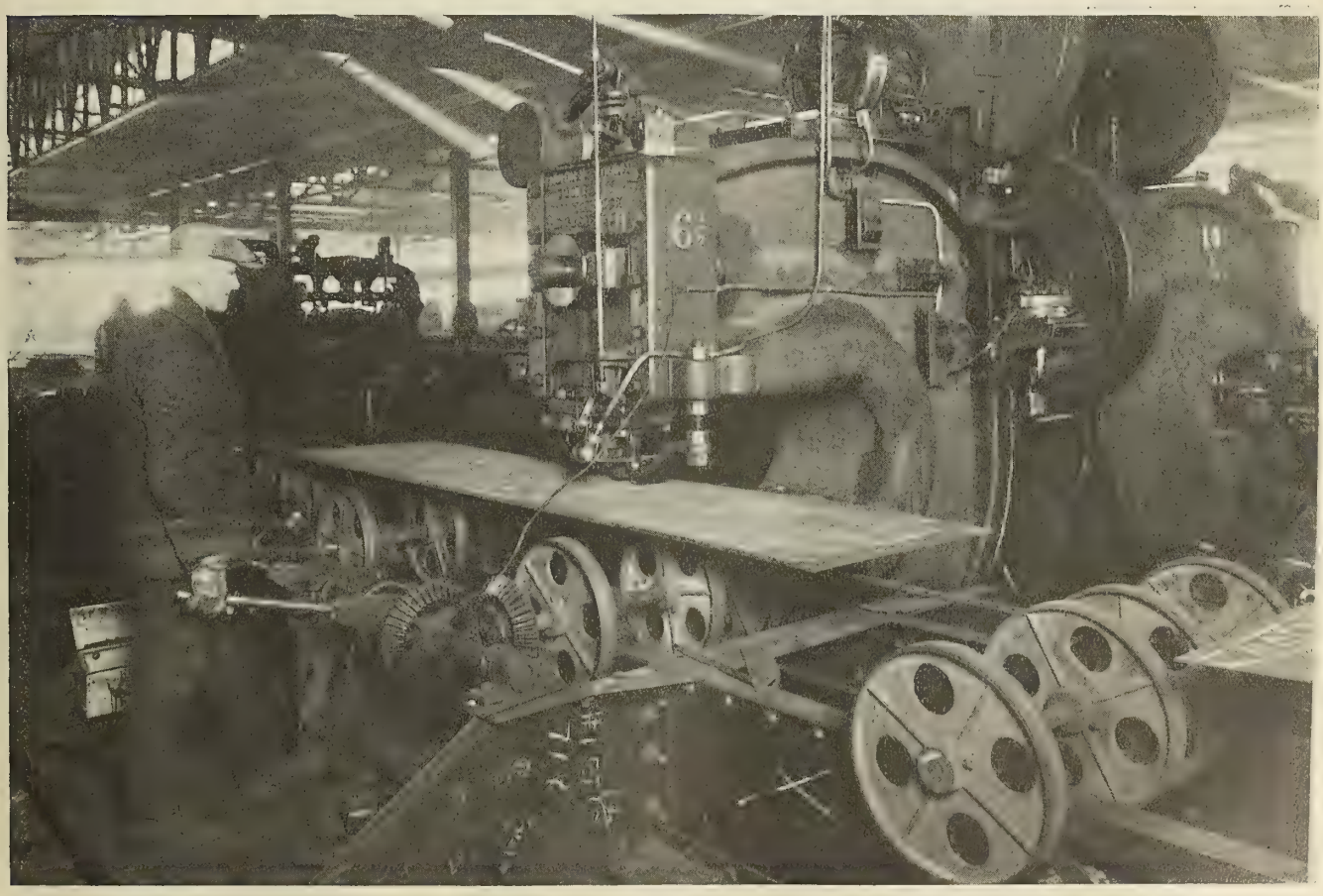


Fig. 25.—Hilles & Jones Punch in Plate Shop. Operator Is Handling Plate with Lysholm Spacing Table

Fig. 26.—Special Beveling and Flanging Machine at Angle Furnace

Fig. 27.—Plate Furnace (Plate and Angle Furnaces Supplied by American Shop Equipment Company)

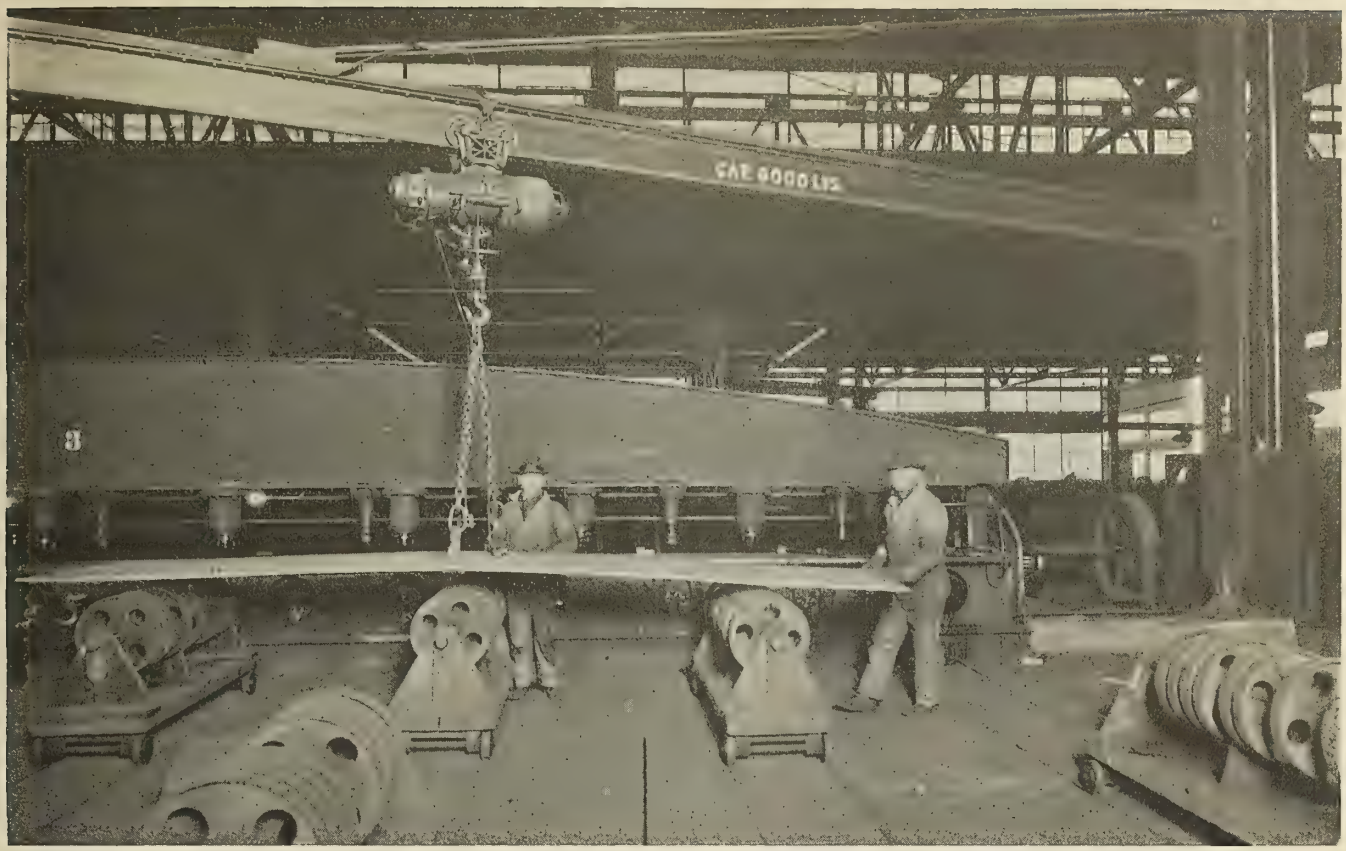


Fig. 28.—Shepard 3-Ton Electric Hoist Operating on Jib Crane Used for Transferring Plates from Roller Skids to Plate Planer

Fig. 29.—One of the 40-Foot Hilles & Jones Plate Planers in Operation

Fig. 30.—37-Foot Hilles & Jones Bending Rolls. Served by Shepard Electric Hoist on Jib Crane

Fig. 31.—Oxy-Acetylene Cutting Apparatus Is Widely Used in the Assembling Shop

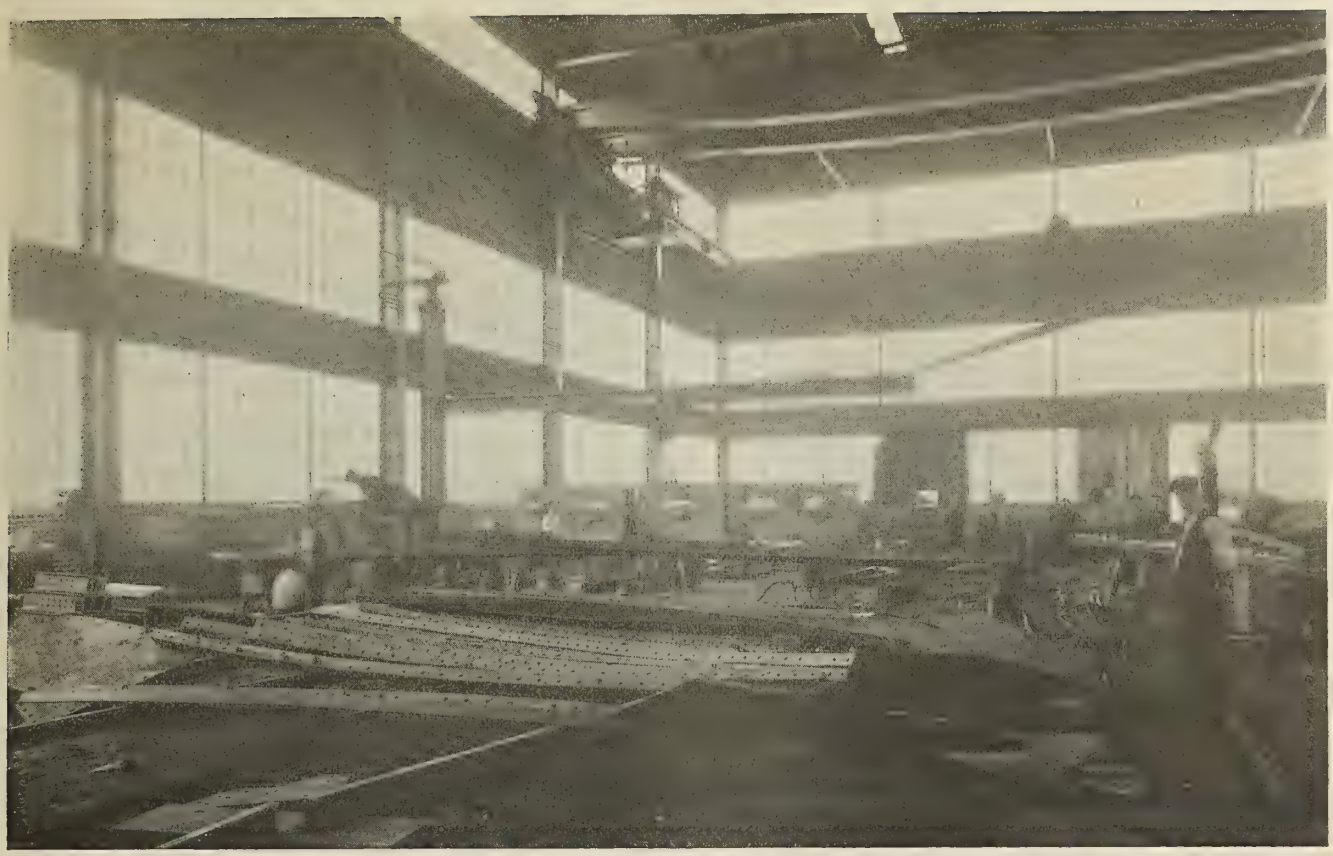


Fig. 32.—Corner of Assembling Shop. Large Sections Are Fitted Up and Riveted in the Shop Before Going to the Shipways

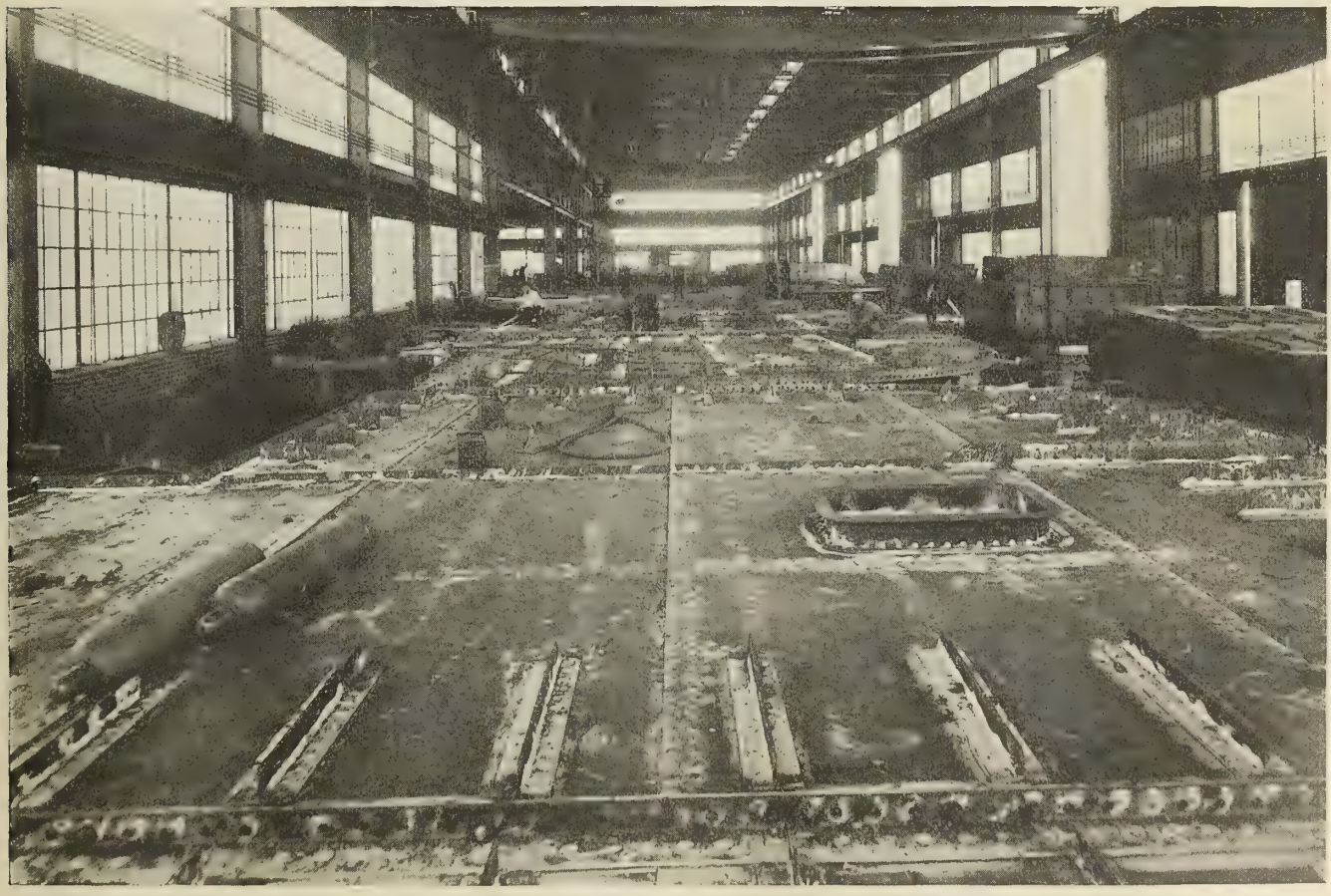


Fig. 33.—General View of Assembling Shop, Showing Bulkheads Riveted Up Ready for Installation on the Ships

Fig. 34.—Large Bay of Boiler Shop

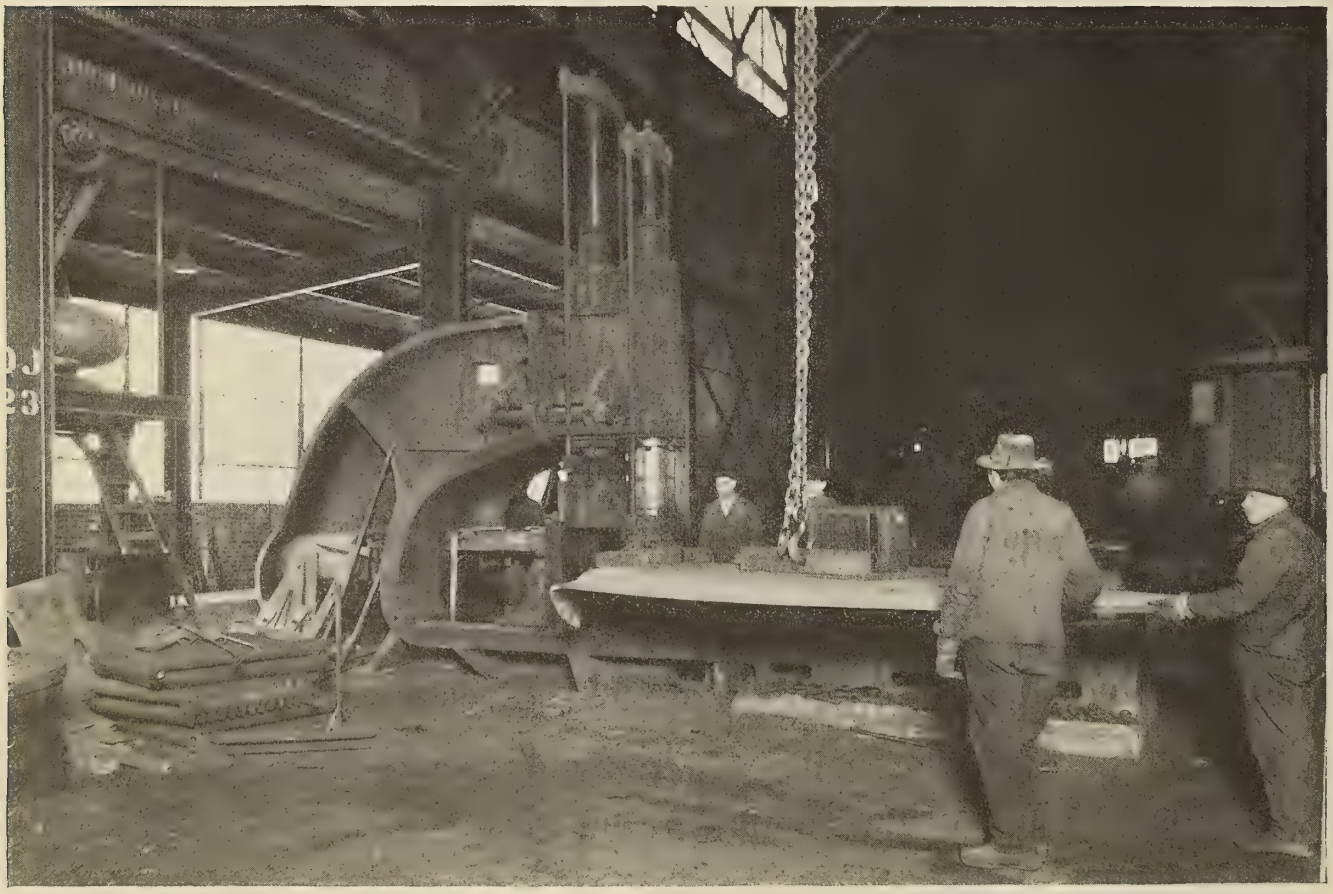


Fig. 35.—Flanging Boiler Head on Hydraulic Sectional Flanging Machine

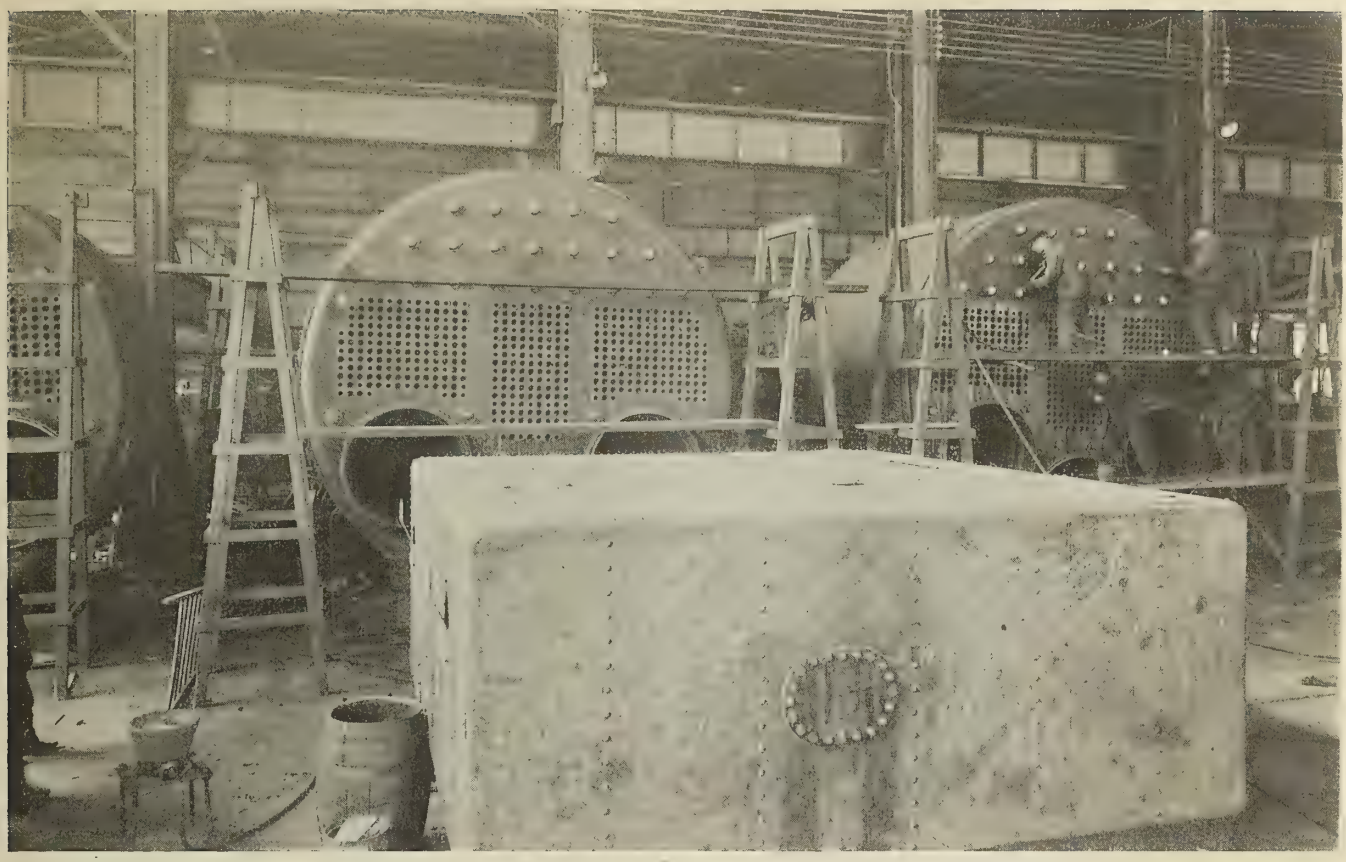


Fig. 36.—Assembling Floor of the Boiler Shop

Fig. 37.—General View of the Boiler Shop

Rand air compressors of 2,500 cubic feet capacity; two Laidlaw-Dunn-Gordon air compressors, of 2,800 cubic feet capacity, and one Bury air compressor of 5,000 cubic feet capacity. These machines are driven by Allis-Chalmers motors; there is also a hydraulic equipment consisting of twin 4½-inch by 12-inch pumps, supplied by the Oil City Pump & Machine Company, to furnish hydraulic pressure of 1,500 pounds per square inch. The buildings are heated by a hot water system, operated from a central heating plant in the yard.

The main shops in the yard are of steel frame construction with corrugated iron walls. At the entrance to the yard is a two-story brick office building, the main floor being occupied by the auditing department and lunch rooms and the second story by the executive offices and engine and hull drafting departments. Alongside the main office is the main entrance for the employees to the yard, with a time clock house and separate locker room equipped with individual lockers for each workman, as well as wash basins and shower baths.

Contractors and Officers of the Company

The buildings in the yard were put up by the Belmont Iron Works, Philadelphia, and Lewis F. Shoemaker & Company, Philadelphia. The concrete work on the shipways was carried out by the Raymond Concrete Pile Company, Philadelphia.

J. N. Pew, Jr., is president of the Sun Shipbuilding Company and J. Howard Pew, the vice-president. Robert Haig, formerly Lloyd's representative in Philadelphia, is general manager, Albert Ed. Saunders, naval architect, A. A. Howitz, chief engineer and J. K. Graham, manager of the hull department.

Morse School for Shipfitters

Elementary and Advanced Courses for Shipfitters Given at Morse Dry Dock and Repair Yard

SUPPLEMENTING the work which is being done by the New York State and city educational boards in establishing schools for shipworkers, the Morse Dry Dock and Repair Company, Brooklyn, N. Y., has opened a school for its own men. Two courses for shipfitters have been arranged—an elementary and an advance course.

Because of limited space and facilities, the classes have been restricted to a selected list of employees. About fifty men have been chosen, and only that number can be accommodated at the present time. As the courses are not long and are designed to cover but a short period of time, it is hoped that every man in the yard who desires to take advantage of them will, sooner or later, be afforded an opportunity to do so. When additional room and equipment are available the size of the classes will be gradually extended to meet the demands.

The elementary course consists of twelve lessons, and the classes meet every Monday and Thursday between 4 and 6 P. M., the hours being arranged to avoid interference with the work in the yard and also the supper time of the men attending. The advanced course consists of sixteen lessons, and the classes meet at the same hours on Tuesdays and Fridays. Walter Crawford, foreman of the hull department, is in charge of the classes.

The success which has attended the first school opened by the city and State authorities (the schools in Staten Island) and the overwhelming interest displayed by shipworkers has demonstrated the value of the project, and every effort is being made to hurry the establishment of other schools in Brooklyn and Manhattan.

The Morse school has been limited to the teaching of shipfitting to start with, but it is possible that, later on, courses in other branches of the trade will be given.

The elementary course in the Morse school is outlined as follows:

Lesson 1.—Method of making small paper templates for liners, particular attention being paid to lap, squareness and fit.

Lesson 2.—Study of uses and making of short angle clips and brackets. Study of squareness, fit and allowances.

Lesson 3.—Study of methods of fitting, marking and making of straight plates, deck, tank top plates. Study of correct application of templates, checking spaces in templates.

Lesson 4.—Study of laying out and making of auxiliary machinery foundations and general constructional work in angles, plates, channels. Study of angles and curves.

Lesson 5.—Methods of lining off and obtaining level lines, marking of positions of foundations.

Lesson 6.—Study of construction methods of laying out and making of main ship parts. Keels.

Lesson 7.—Frames, webs.

Lesson 8.—Shell plating.

Lesson 9.—Bulkheads.

Lesson 10.—Stem and stern.

Lesson 11.—Longitudinals.

Lesson 12.—Blueprint reading for shipfitters.

The advanced course is as follows:

Lesson 1.—Standard rivet sizes.

Lesson 2.—Spacing of rivets.

Lesson 3.—Study of suitable rivet spacing for odd parts, clips, brackets, etc.

Lesson 4.—Requirements for plain, watertight, oiltight work.

Lesson 5.—Study of parts to be planed for calking.

Lesson 6.—Laying out and study of level lines.

Lesson 7.—Study of shell plating. Method of laying out and repairing.

Lesson 8.—Study of parts to be furnaced and parts to be fitted and drilled in place.

Lesson 9.—Tank top and margin plates; study of development of plates. Repair of margin plates, the fitting of doubling plates.

Lesson 10.—Shaft tunnel and thrust recess trunk; study of development.

Lesson 11.—Mast and funnel making; method of laying out and building.

Lesson 12.—Bulkheads, method of laying out, molding and repairing.

Lesson 13.—Development of irregular shapes.

Lesson 14.—Watertight and non-watertight doors and manholes. Study of construction and fitting.

Lesson 15.—Deckhouses, casings, etc. Study of construction and building.

Lesson 16.—Marking of plates and conventions of markings.—*The Dry Dock Dial.*

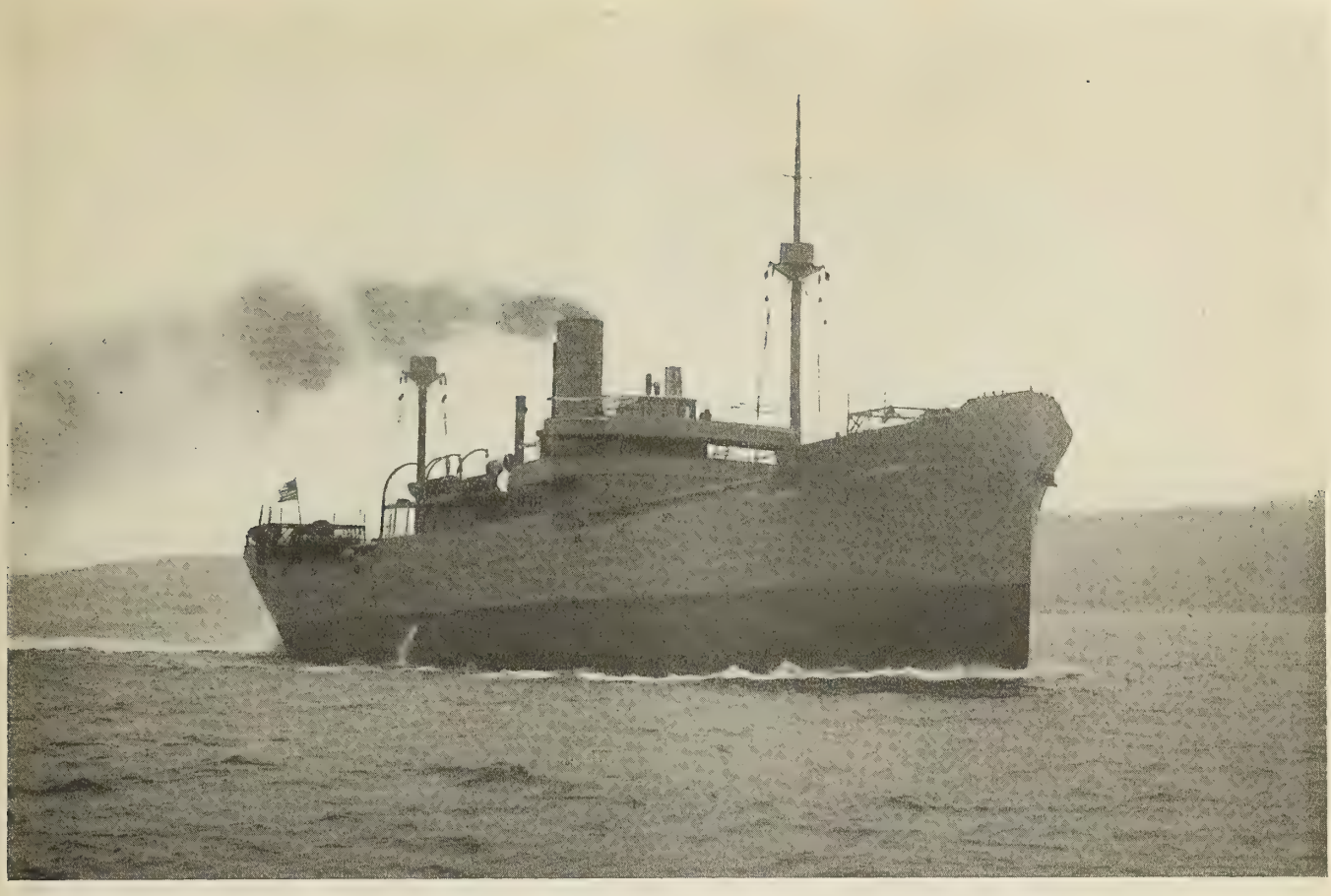


Fig. 1.—S. S. *Jupiter*, First Vessel Built by Standard Shipbuilding Corporation for Emergency Fleet Corporation

The Shooters Island Shipyard

Reconstructed Plant of the Standard Shipbuilding Corporation — Its Standard Cargo Ships

AMONG the many shipyards which have grown up in the New York District during the past few years, the Standard Shipbuilding Corporation, at Shooters Island, is one of the most progressive, and bids fair to be a lasting asset to the port. The president of the company, José Marimon, has large interests in Cuba and the United States, and has a long list of successful enterprises to his credit.

Enlargement of the Plant

At the time when Mr. Marimon obtained control, in October, 1916, the capacity of the Shooters Island plant was very small, and he immediately took steps to make a real shipyard of it. Mr. E. S. Godoy, vice-president, was installed as general manager, and under his direction six building berths were put up, and the size of the island was increased about one-third by bulkheading and filling in shoal water on the north side. Extensions to the blacksmith shop and machine shop were put in hand, and a large quantity of new machinery ordered.

A serious blow was given to the production programme on December 28, a year ago, by a fire, which burned to the ground a frame building containing the mold loft and plate and boiler shop. All the molds already made for the ships which had been started were destroyed, as well as the machinery in the building, and a set of boilers under construction sustained some damage.

With characteristic energy, Mr. Godoy immediately set about repairing the damage. A new mold loft was started and on the fifteenth day it was finished and in use. A new steel building was ordered for the plate and boiler shops, and work started with a view of salving some of the machines.

The new building is 400 feet in length and 240 feet wide, divided into four 60-foot bays; three for the plate and angle shop, each with two 10-ton traveling cranes; and one for the boiler shop, served by two 50-ton cranes.

The machine shop, with the new extension, is 461 feet by 84 feet and is now one of the best equipped in the country.

Vessels Launched

The Standard Shipbuilding Corporation is now preparing to launch its fourth standard freighter for the U. S. Shipping Board Emergency Fleet Corporation. Two others, the *Muscatine* and the *Passaic*, are at present fitting out; and the first, the *Jupiter*, has already been delivered and has left an American port on her maiden voyage.

These ships are all similar. They are designed to carry 7,300 tons deadweight, and maintain a speed of 10½ knots.

The original designs of hull and engine were purchased, but they have been developed and all the necessary piping arrangements laid out under the direction of Mr. G. N.

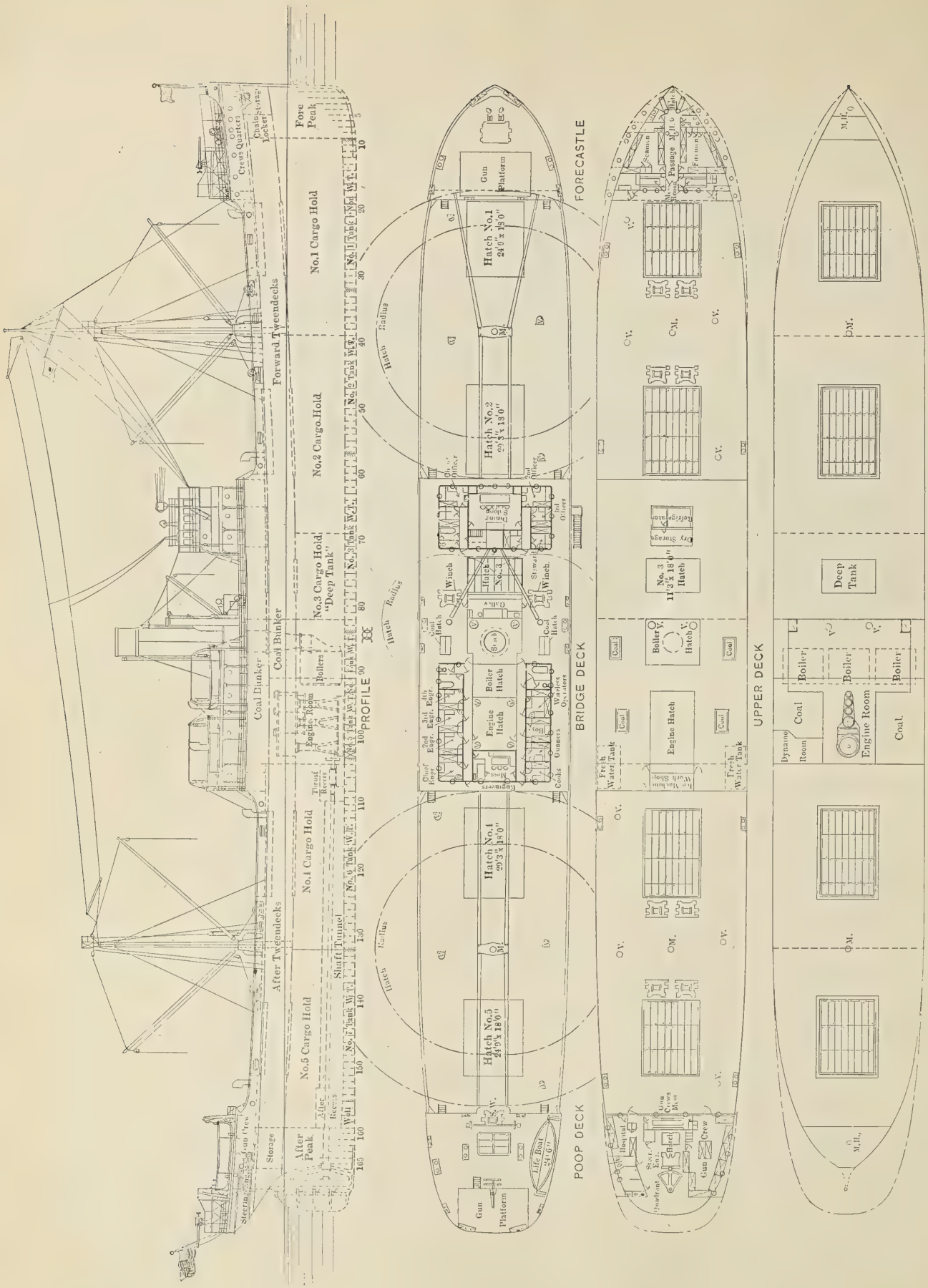


Fig. 2.—Capacity and Deck Plans of Standard Cargo Vessels Built by Standard Shipbuilding Corporation

Scott, the chief engineer of the Corporation, who also has had complete charge of the construction.

All the freighters at present being built at this plant were originally ordered by foreign interests, but on the outbreak of war between the United States and Germany they were requisitioned by the Emergency Fleet Corporation.

Description of the Standard Freighters

They are single screw steel ships, built and outfitted to Class 100-A1, under special survey of Lloyds Register of Shipping, and since they have been requisitioned by the Government they have been modified to comply with the requirements of the U. S. Steamboat Inspection.

They are of the two deck type with bridge, forecastle, and poop; two masts, one funnel, complete double bottom and seven watertight steel bulkheads extending to the upper deck, with a deep tank forward of the machinery space. The accommodation for the officers is amidships, for the crew in the forecastle, and for the armed guard in the poop.

The bridge, with pilot house, chart room, and wireless room, is arranged just forward of amidships, with the captain's quarters below and the main saloon with the officers' quarters on the deck below that.

The vessels have straight stem and semi-elliptical stern, with machinery amidships, and have been designed for the carriage and expeditious handling of bulk freight. For this purpose they are fitted with 11 winches and 10 derricks.

The principal dimensions are as follows:

Length over all	392 feet 6 inches
Length of Lloyd's measurements	377 feet 0 inches
Breadth molded	52 feet 0 inches
Depth at side to upper deck	29 feet 6 inches
Height between decks	10 feet 1 inch
Draft	23 feet 6 inches
Total deadweight on above draft	7,000 long tons
Indicated horsepower	2,500
Speed	10½ knots

The Hull

The keel is of the flat plate type in long lengths with butts connected by double butt straps. The center keelson, which is continuous, is fitted in conjunction with the flat plate keel and a double bottom; increased in the boiler space and reduced at the ends. Double angles, increased in the boiler space, are worked in at the keel and tank top.

In addition to the center keelson, there are two longitudinal side girders in the double bottom on either side of the center line. They are continuous between solid floors and are increased in the boiler space and reduced at the ends. Extra longitudinals are fitted under the main engine seating, and a half depth longitudinal in way of the double frames forward.

For three-fifths length forward and aft of the machinery space to the after peak bulkhead, solid floors are fitted from the center girder to the margin plate. Skeleton floors are fitted on the remaining frames. All solid floors with lightening holes are fitted in both peaks, and in the engine and boiler space. The double bottom runs throughout the length of the vessel, from the collision bulkhead to the after peak bulkhead, and is divided by watertight floors into seven fore-and-aft compartments. A deep ballast tank is fitted forward of the boiler room.

There are seven watertight bulkheads increased in thickness from the top to the bottom and stiffened with vertical channel stiffeners. The bulkheads are bracketed to the tank top and to decks.

From margin to upper deck the frames are 10-inch channels, spaced 27 inches from center to center amidships; each alternate main frame runs up to the bridge deck. The shell plating is arranged as "in" and "out" strakes, with full thickness liners, fitted at all outer strakes. Bilge keels constructed of bulb plates and angles are fitted for about 185 feet amidships.

Provision is made for the speedy handling of cargo by having five especially large hatches.

Propelling Machinery

The propelling machinery consists of a three-cylinder, triple expansion engine, having cylinders 24 inches, 40 inches and 70 inches in diameter by 48-inch stroke, supplied with steam by three single-ended Scotch boilers, designed for a working pressure of 190 pounds per square inch. The boilers are 14 feet in diameter by 12 feet long over all, each boiler having three corrugated furnaces 42 inches inside diameter, each leading to a separate combustion chamber. These boilers are designed for forced draft and fitted with an installation of the Howden type with Sturtevant blowers, the furnace fronts being designed by the builders.

The main condenser is of the Wheeler Admiralty type with 3,500 square feet of cooling surface, and is supported on a separate foundation behind the main engine. There is a direct connected air pump of the Edwards type with two bilge and two feed pumps, all driven off the pump levers on the low pressure engine. There is an independent centrifugal circulating pump with 14-inch suction and discharge connections which is driven by a 10-inch by 10-inch vertical engine.

The auxiliary outfit is very complete and includes one 500-square foot auxiliary condenser with combined air and circulating pump, one 12-inch by 8-inch by 24-inch vertical simplex feed pump, one Reilly multicoil feed water heater, one Reilly evaporator of 25 tons capacity, as well as an especially large ballast pump, fire pump, general service pumps and fresh water and sanitary pumps, all of which are of the horizontal duplex type.

The electrical equipment consists of two 15-kilowatt, direct-connected generator sets manufactured by the General Electric Company, which furnish power for the lighting, machine tools in the engine room, and wireless apparatus.

There is provision for carrying 83 tons of fresh water, and this, with a bunker capacity of 1,588 tons, gives the vessels a very large steaming radius.

Commodious Accommodations

In fitting up the crew's accommodation, especial attention has been paid to the comfort of the men who are necessarily cooped up for long periods. The officers' rooms are all of exceptional size, and are finished in white enamel and mahogany, with hair cushions on the seats.

The captain's accommodation and the main dining saloon are particularly noteworthy, all of them being paneled complete in mahogany with white ceilings.

The Standard Shipbuilding Corporation has had several difficult problems to meet in providing for the very large crew necessitated by the war conditions, the number of men being increased by 150 percent, but by taking advantage of the poop, a very neat arrangement has been worked out, which gives exceptional accommodations for all hands.

Chain falls should be looked over now and then. Worn sheeve blocks are dangerous, as are also worn pins.

Five Thousand-Ton Deadweight Fabricated Steel Cargo Steamer for Emergency Fleet

Standard Type of Vessel Being Built by Submarine Boat Corporation at Newark Bay Plant—Fabricating Principle Adopted

BECOMING thoroughly convinced by its success two years ago in building for the British Admiralty 550 submarine chasers, the parts of which were fabricated in one place and then put together in another location, that the same principles could be successfully applied to the building of large steel cargo vessels, the Submarine Boat Corporation of New York took up the design of such a vessel when the United States entered the war to meet the urgent demand for the rapid production of seagoing cargo tonnage on a large scale.

The basic principle of building fabricated ships is by no means new or untried. For years small vessels have been fabricated in English yards and shipped in knock-down form to the river Nile and other foreign waters, where they were assembled and placed in service. More recently the same principle has been utilized to a limited extent with marked success in both English and American shipyards on large steel vessels. The main drawback to increased production of steel merchant vessels when the United States entered the war was the fact that the steel mills for rolling ship plates and shapes were engaged to capacity to meet the enormous demands imposed by both naval and merchant ship construction. To overcome this difficulty, the Submarine Boat Corporation proposed the substitution of structural shapes and plates, which could be obtained from the steel mills in quantity, in place of the ordinary shipbuilding materials. This plan proved entirely feasible, and, as a result, the design for a 5,000-ton deadweight carrying capacity cargo vessel, described in the following pages, was worked out.

The design differs little from that of an ordinary cargo ship, except that it has been simplified by the greatest possible use of flat work and straight line sections which could be more easily and quickly fabricated by the structural steel and bridge building shops throughout the country. The tank top is carried out straight to the sides of the vessel, and in this respect follows the usual Lake practice. Where the ends fine in the usual form of margin plate is dispensed with, the sketch plates at the ends of the tank top strakes being increased in thickness to provide the necessary strength. The sides of the vessel are perfectly straight, except at the bow, where there is a slight flare. The decks are also perfectly flat, having neither crown nor sheer, except that from the forward end of the first hatch to the stem the deck has a straight sheer of 5 feet to give added buoyancy. The parallel middle body extends for 42.5 percent of the length of the vessel, the form of the hull having been determined from tests in the Washington towing tank.

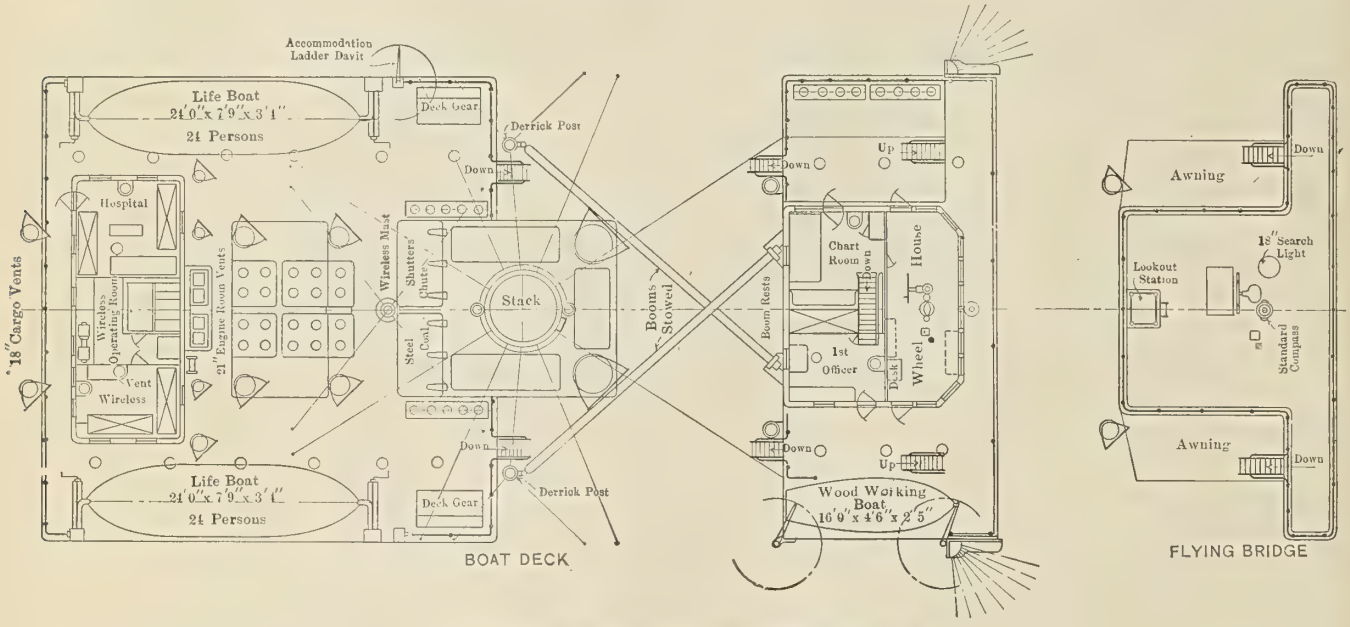


Fig. 1.—Plans of Boat Deck and Flying Bridge

Over 96 percent of the hull by weight is fabricated in outside shops. The shipyard, therefore, becomes simply an assembling department in the building of the ships. Plates which require rolling are laid out, sheared and punched in outside shops and shipped flat to the Newark yard, where they are rolled, as the large bending rolls required are not available in the bridge shops. Furnaced plates are pressed in hydraulic presses in the outside fabricating shops and shipped to the yard in blank form, repetition work making it possible for the outside shops to get out the dies required for this work and use them over and over again economically. Work on the shipways is reduced as far as possible by riveting together in the outside shops as large pieces as can be transported by rail to the yard. Detail drawings have been worked out for every piece of material going into the ship, 330 drawings having been made for the hull alone. In this way the plates are ordered to exact size, while the sketch plates at the ends of the vessel are designed with no re-entry cuts. The

5,000-TON DEADWEIGHT FABRICATED STEEL CARGO STEAMER

Designed for U. S. Shipping Board Emergency Fleet Corporation and Built by Submarine Boat Corporation, New York

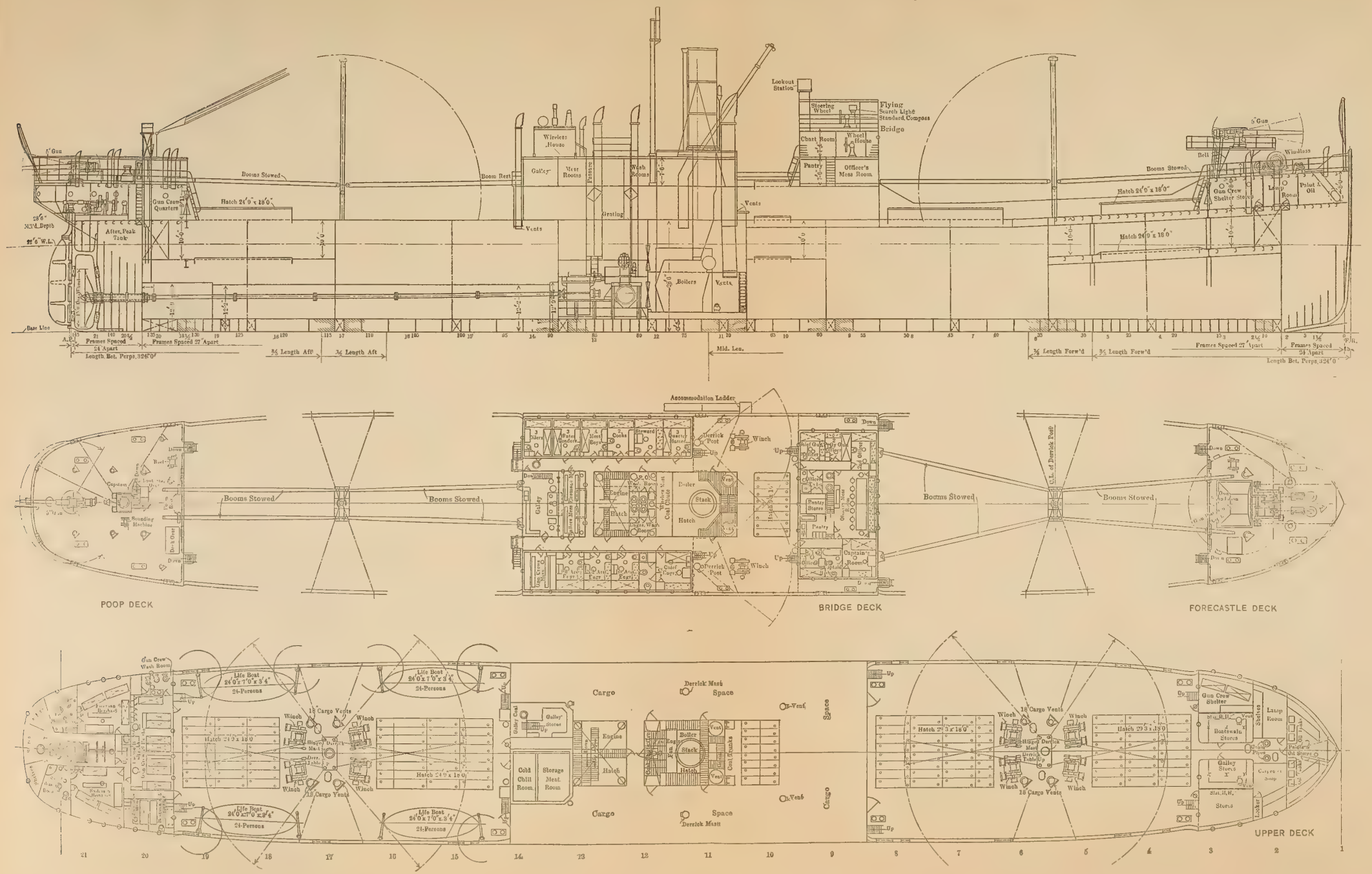


Fig. 2.—Profile and Deck Plans

5,000-TON DEADWEIGHT FABRICATED STEEL CARGO STEAMER

Designed for U. S. Shipping Board Emergency Fleet Corporation and Built by Submarine Boat Corporation, New York

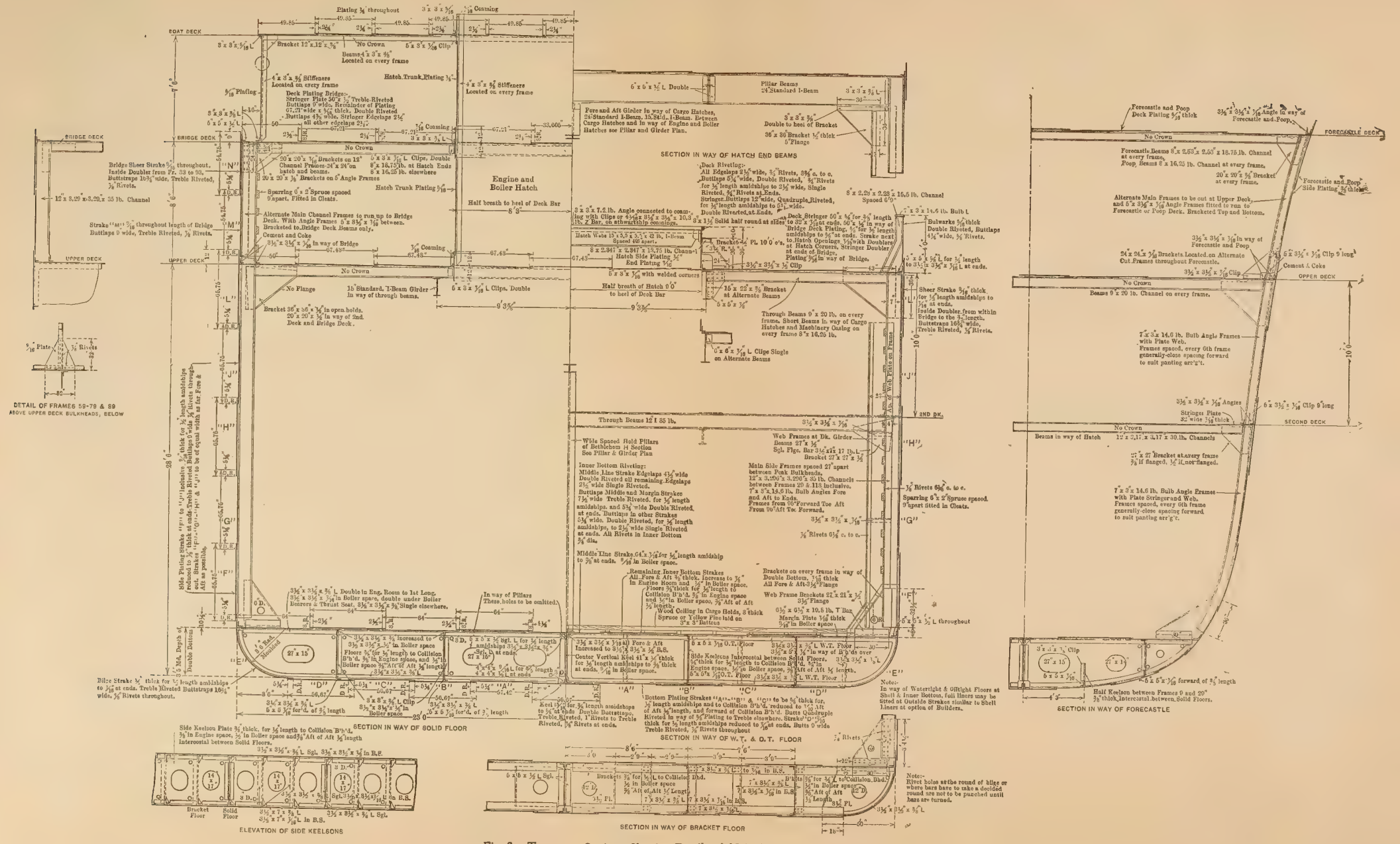

SECTION IN WAY OF HATCH END BEAMS
SECTION IN WAY OF SOLID FLOOR
SECTION IN WAY OF W. T. & O. T. FLOOR
SECTION IN WAY OF BRACKET FLOOR
SECTION IN WAY OF FORECASTLE
ELEVATION OF SIDE KEELSONS
DETAIL OF FRAMES 59-79 & 89
ABOVE UPPER DECK BULKHEADS, BELOW
Engine and Boiler Hatch
Hatch Trunk Plating
Deck Plating Bridge
Stringer Plate
Buttstraps
Bridge Sheer Strake
Strake "M"
Alternate Main Channel Frames to run up to Bridge Deck. With Angle Frames
Cement and Coke
Sparring
Bracket
No Flange
Through Beams
Wide Spaced Hold Pillars of Bethlehem H Section
Inner Bottom Riveting:
Middle Line Strake
Main Side Frames spaced
Bilge Strake
Side Keelson Plate
Intercostal between Solid Floors.
Bottom Plating Strakes
Keel
Forecastle and Poop Deck Plating
Forecastle Beams
Poop Beams
Alternate Main Frames to be cut at Upper Deck, and
Cut Frames throughout Forecastle.
Stringers Plate
Beams in way of Hatch
Half Keelson between Frames
Note:-
Rivet holes at the round of bilge or where bare bars to take a doubled round are not to be punched until bars are turned.

Fig. 3.—Transverse Sections, Showing Details of Hull Construction and Scantlings

frames at the ends of the vessel are bulb angles and are furnaced and bent in the yard. In the fabricated work all holes are punched and reamed out to neat size.

All of the material for the ships is ordered in accordance with instructions from the Washington office of the Emergency Fleet Corporation.

The principal dimensions of the vessel are as follows:

Length over all, about	335 feet 6 inches
Length betwen perpendiculars	324 feet
Beam, molded	46 feet
Depth at side to upper deck	28 feet 6 inches
Load draft, about	22 feet 6 inches

Built on the transverse system of framing, with a double bottom throughout, the vessel is of the single-deck type, with a partial second deck at the ends and also with bridge, forecastle and poop. All of the decks are worked level fore-and-aft, as well as transversely. In way of the wells, the bulwarks are of solid steel.

As shown by the drawings, the vessel has a straight stem with slight rake, a semi-elliptical stern and is rigged with one steel pole mast with a housing topmast located amidships and six derrick posts with cargo derricks and a single smokestack. In all, there are five cargo hatches at the upper deck, one hatch in the bridge deck and a small hatch in the poop deck.

Seven watertight steel bulkheads, six of which extend to the upper deck, divide the hull into four cargo holds, a deep tank and engine and boiler spaces.

The holds and 'tween decks will be used for cargo. The space in the forecastle will be used for crew's quarters, stores and a carpenter shop, and the space in the poop for the steering gear, gun crew and cargo or stores. In the bridge the space will be used for stores and cargo.

The forward and after peak tanks are arranged as salt water trimming tanks, and will be used for ballast. The after peak is also piped for carrying fresh water when needed. The entire double bottom, except compartment 4, will be used for oil fuel, the center keelson being made watertight throughout. Compartment 4, with the watertight center division, forms two tanks for boiler feed. A separate settling tank is also fitted in the boiler room, as shown on the plans. Double-bottom bilge wells are fitted all across and at the wings only for drainage of the deep tank bilges. While the double-bottom tanks are arranged primarily for carrying fuel oil, they will also be arranged for carrying water ballast.

As shown by the plans, the galley, officers' messroom, deck officers', stewards' and engineers' quarters, wash rooms, storerooms, cooks, etc., are located in the bridge deck houses.

Hull Construction

The stem is a rolled steel bar 9½ inches by 2½ inches, extending down below the turn of the forefoot and shaped to suit the keel at the lower end. It is designed in two lengths fitted with a scarf, although the stem may be in one piece if desired, of a uniform section throughout. If made in two lengths, the lower section adjoining the keel plate may be of cast steel instead of rolled steel.

The stern frame may be a forging or cast steel. The propeller post is 9½ inches by 6½ inches, and the rudder post 8½ inches by 6½ inches. The part of the frame between the propeller and rudder posts is flattened out at the heel. The scarfs are fitted above and below the shaft boss in the propeller post and in corresponding locations in the rudder post. The stern frame is provided with a boss for the stern tube, gudgeons for pintles and rudder stops. The rudder is of the single-plate type, with wrought or cast steel frame and arms.

The keel is of the flat-plate type 15/16-inch thick for three-fifths length amidships, reduced to ⅝ inch at the ends. It is worked in long plates joined with double butt straps, triple riveted with 1-inch rivets amidships and triple riveted with ⅞-inch rivets at the ends.

Double-Bottom Ballast and Fresh-Water Tanks

The double bottom, which extends throughout the length of the vessel from the collision bulkhead to well forward of the after-peak bulkhead, is constructed with open and solid floors, divided by watertight and oiltight floors, as shown on the plans, into six fore-and-aft compartments. The double-bottom tanks from forward to aft are as follows:

Tank No. 1, from collision bulkhead, fuel oil tank with watertight center division. Tanks Nos. 2 and 3, fuel oil tanks with watertight center division. Tank No. 4, boiler feed water, with watertight center division. Tanks Nos. 5 and 6, fuel oil tanks with watertight center division.

Access to No. 1 tank can be gained from No. 1 hold; to No. 2 tank, from No. 2 hold; to No. 3 tank, from the fireroom; to No. 4 tank, from the engine room; to Nos. 5 and 6 tanks, from the shaft tunnel and also from the holds.

At the after end of Nos. 1, 2, 3 and 4 holds, bilge suctions are provided at the wells formed in the double bottom. In the deep tank space forward of the boiler room side wells are fitted. A separate pump well runs clear across the tank at the after end of the engine room, and a similar pump well is provided at the after end of the shaft tunnel. Cofferdams separate the fuel oil and feed tanks in the fireroom and are provided with bilge suctions.

Framing

The main frames above the tank top are channels spaced 27 inches centers amidships, and bulb angles spaced 24 inches between centers at the ends. The side frames between the peak bulkheads are 17 inches by 3.29 inches by 3.29 inches by 34-pound channels between frames 29 and 113, inclusive. The frames fore and aft of the peak bulkheads are 7 inches by 3 inches by 14.6-pound bulb angles.

Alternate main channel frames within range of the bridge run up to the bridge deck with an alternate angle frame 5 inches by 3½ inches by 7/16 inch from the upper deck. Alternate main frames also run up to the poop and forecastle decks with an alternate angle frame from the upper deck. Frames in the holds in way of excessive bevel may be of angles or bulbs as approved.

The frames in the inner bottom on solid floors are 3½-inch by 3½-inch by ⅜-inch angles throughout, doubled from collision bulkhead to three-fifths of the length forward. The frames on the open floors in the inner bottom are also of angles, but they are 7 inches by 3½ inches by 7/16 inch to the lower turn of the bilge, 3½ inches by 3½ inches by ⅜ inch in way of the bilge. On the solid floors from frames 9 to 29, inclusive, the angles are 5 inches by 5 inches by 7/16 inch.

Reverse frames, consisting of angles 3½ inches by 3½ inches by ⅜ inch, are worked continuously on top of all solid floors in the double bottom. They are increased under the boilers and doubled throughout the engine space and under boiler bearers. The reverse frames in the peaks consist of angles 3½ inches by 3⅜ inches by ⅜ inch, fitted on every floor, while the reverse frames on the bracket floors are 7-inch by 3½-inch by ⅜-inch angles.

The center vertical keel is fitted continuous with the flat plate keel and is 41 inches by ½ inch for one-half the length of the hull amidships, increased to 9/16 inch in the boiler space and reduced to ⅜ inch at the ends. The center vertical keelson is continuous forward of frame 132 to

frame 9 and intercostal aft of frame 132 and forward of frame 9. The keelson is watertight between frames 9 to 34, 35 to 61, 62 to 70, 71 to 87, 88 to 113, and non-watertight from frames 114 to 132. Double angles, 3½ inches by 3½ inches by 7/16 inch, connect the center keelson to the tank top, increased to 3½ inches by 3½ inches by ½ inch in the boiler space. Double angles, 4 inches by 4 inches by 9/16 inch, are worked at the keel for three-fifths the length and reduced to 4 inches by 4 inches by ½ inch at the ends.

Two longitudinal side keelsons are fitted in the double bottom on each side of the center line. They are continuous between solid floors and are increased in the boiler space. The longitudinal plates are connected to the shell plating by angles and also to the tank top plating by angles which are increased in the boiler space. They are connected to the solid floors by angles and to the frames and reverse frames at open floors by angles.

Throughout the length of the ship the margin plate of the tank top is fitted level to the bilges and is continuous, being increased in thickness in the boiler space. The margin plate is connected to the shell by an angle bar.

Web frames are fitted in the engine space and in the 'tween decks over the watertight bulkheads. Side stringers are fitted forward in the hold and in the 'tween decks only as required for panting strength at the ends. Portable strong beams are fitted in the engine and boiler space.

Deck Beams

None of the deck beams has either camber or pitch. At the upper deck through-beams, consisting of 9-inch by 20-pound channels, are fitted to every frame. Short beams, consisting of 8-inch by 16.25-pound channels, are fitted in way of the cargo hatches and machinery casings. Strong beams, consisting of 24-inch standard I-beams, are fitted in way of the hatch end web frames.

In the 'tween decks space in holds Nos. 1 and 4 only deck beams consisting of 12-inch by 3.29-inch by 3.29-inch by 35-pound channels are fitted on alternate frames. The through beams at the bridge deck, which are fitted to every frame, are 8-inch by 16.25-pound channels. At the poop and forecastle deck beams consisting of 8-inch by 2.53-inch by 2.53-inch by 18.75-pound channels are fitted on every frame. At the boat deck the beams consist of 4-inch by 3-inch by ⅜-inch angles fitted to every frame.

Deck and Shell Plating

The upper forecastle, poop and bridge decks are complete steel decks with the plating fitted in in-and-out strakes with parallel liners. The boat deck is also plated throughout.

The shell plating is arranged in in-and-out strakes with full thickness liners fitted at all out strakes. At the stern frame the plating is of midship thickness. Three strakes next to the keel are maintained at midship thickness to the collision bulkhead. The boss plating is 11/16 inch thick. Details of the shell and deck plating, as well as of the riveting, will be found on the midship section.

Bulkheads

As shown on the general plans, there are in all seven watertight bulkheads, six of which extend to the upper deck and one to the 'tween deck level. The collision bulkhead is extended watertight to the forecastle deck. The forward bulkhead of the deep tank extends only to the 'tween deck level. Vertical stiffeners only, spaced 30 inches apart, are fitted to the bulkheads.

Fresh water for culinary use is carried in two fresh-water tanks placed in the engine room, having a total capacity of about 7,000 gallons. A gravity tank of about 400 gallons capacity is placed on the boat deck.

In the holds, one row of wide-spaced pillars of H-section, filled with wood to prevent chafing, is fitted; the pillars fitted at the hatch ends are set back one beam space. Deck girders worked in way of the hatch coamings, as shown on the plans, are carried with girder beams, which in turn are supported with a center pillar, all designed to carry the loads in accordance with best practice.

Cargo-Handling Equipment

Cargo is handled through five main cargo hatches through the upper deck and two hatches through the second deck beams, one hatch through the bridge deck, one hatch through the poop deck and a watertight hatch over the peak tank.

Six steel derrick posts are fitted at the hatches, as shown in the general plans. Holes are cut in the posts under the decks for ventilation and fitted with a sliding plate cover. The derrick posts in the wells are of the hinged-down type. The tops of the derrick posts at No. 3 hatch are fitted with a mushroom top vent.

At hatches Nos. 1, 2, 4 and 5 eight cargo booms are fitted, designed for handling 5-ton loads.

The hatch covers are fitted in built-up sections made of 3-inch spruce fitted with lifting bolts of half-round bar through-bolted. The covers are arranged to lie fore-and-aft on the hatch webs. The deep tank hatches are covered with steel covers.

The cargo will be handled by eight double-cylinder, single-drum, single-geared reversible winches, 8¼ inches by 8 inches, located at the hatches on the upper deck, and two 6¼-inch by 8-inch, double-cylinder, single-drum geared reversible winches, with two winch heads on the bridge deck at hatch No. 3.

The steam winches are connected with galvanized iron steam and exhaust pipes with copper branches from the main line to the winches in such a way that the winches may be driven from either of the main boilers independently of the other. The steam and exhaust pipes to the winches are run on the upper deck, and the deck machinery steam and exhaust is controlled from the engine room.

Watertight Doors

A sliding, watertight door is fitted in the after engine room bulkhead operated by a screw arrangement from the deck. One hinged watertight cargo door is also fitted on each side in the bulkhead forward and weather-tight doors at the after end of the bridge.

Hull Cementing

Reverse feed tanks, fore and after peak tanks, at the lower and upper deck stringers in bridge, poop and forecastle head and all pockets and spaces where found necessary will be cemented with Portland cement and sharp sand. In the reserve feed tank the cement will be about 1½ inches thick. The remaining surface of the reserve feed tank and peak tanks will be thoroughly coated with cement wash.

Inside the chain lockers one coat of bitumastic enamel will be applied. The tank top in the engine room, the engine foundations, tank top in the boiler space, including boiler saddles and bulkheads for 18 inches above the fireroom floor, the bulkheads in the cargo spaces in the bottom for 18 inches above the tank top, including also the shell and frame brackets up to the top of the brackets, and all drain wells will receive one coat of bitumen solution and one coat of bitumen covering. The tank top in the cargo spaces will also be coated with native tar and cement before the ceiling is laid.

The oil fuel settling tank and the double-bottom tanks for fuel oil are left bare inside.

Ventilation

The living quarters, holds and working spaces are ventilated by natural ventilation by means of metal ventilators and cowls.

General Arrangement

The wheel and chart house are on the boat deck, above which is the flying bridge. Aft on the boat deck is the hospital and wireless cabin.

In the forward deck house on the bridge deck are the officers' messroom connected with the pantry and the captain's room and quarters for other officers. Alongside the engine and boiler casing, on the bridge deck, are quarters for the engineers, quartermasters and stewards, while at the after end of the deck house on the centerline is the galley.

The gun and ship's crews are berthed in the poop and forecastle on the upper deck, the space amidships around the engine and boiler casing being given over to cargo space.

Deck Machinery

The deck machinery includes a spur-geared windlass with engine cylinder, 8 inches by 10 inches, located on the forecastle head with the engine on the same bedplate. The windlass is fitted with two wildcats and two winch heads for warping the ship. Both hand and steam steering gear are provided, the steam steering gear being of the right- and left-hand screw type located aft in the poop and direct connected to the rudder head.

Located on the poop is the steam capstan with double 6-inch by 6-inch cylinders. The vessel is lighted with electricity supplied by one 10-kilowatt marine type generating set direct connected and driven by a turbine. For cold storage and refrigeration an ice machine of 1-ton capacity for a direct expansion ammonia system is provided. The living quarters are heated by steam, and a complete set of instruments and appliances for navigating and handling the ship are provided.

Boilers

Steam is supplied at a working pressure of 200 pounds per square inch by two Babcock & Wilcox watertube boilers, having a total heating surface of 5,800 square feet, fired by oil fuel under natural draft by means of Peabody mechanical oil-burning apparatus.

The boilers are arranged athwartships with one common fireroom on the forward side. They are connected by uptakes to a single smokestack extending 76 feet above the base line.

For the oil-burning system there is installed in the fireroom for pumping oil from the inner bottom tanks and discharging to settling tanks, a horizontal duplex pump 7½ inches by 6 inches by 10 inches. The inner bottom and settling tanks are provided with heating coils. The filling line from the deck to the oil tanks is so arranged that the oil transfer pump can discharge overboard through it on both sides of the ship.

To draw the oil from the settling tanks and inner bottom tanks and discharge through strainers and oil heaters to the burners there are two horizontal simplex pumps 4½ inches by 2¾ inches by 6 inches; two fuel oil heaters and duplex suction and discharge strainers are installed in the oil lines so arranged that either strainer can be cleaned without shutting down the pumps. The heaters are supplied with live steam and drain through a trap to the inspection tank. The piping is so arranged that either pump can pump through or around either heater.

Propelling Machinery

Propulsion is by a single, four-bladed screw of about 15 feet 6 inches diameter, driven by a geared Westinghouse turbine designed to develop 1,500 shaft horsepower

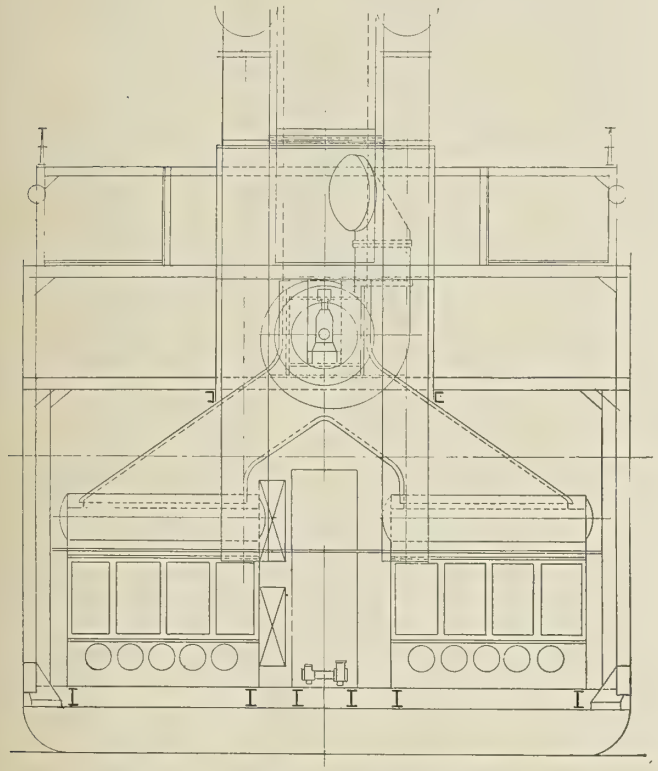


Fig. 4.—Section Through Fireroom

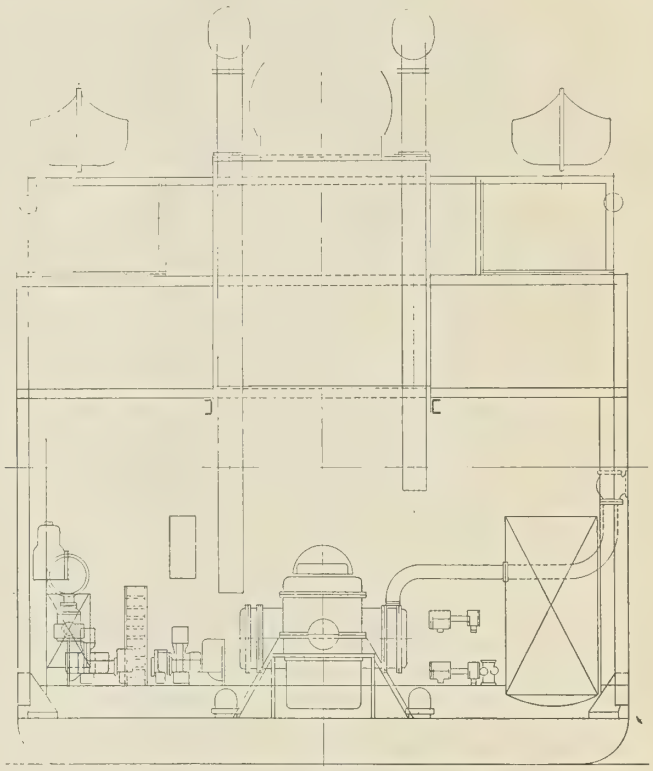


Fig. 5.—Section Through Engine Room

with the propeller shaft turning at 90 revolutions per minute. The turbine is connected to the propeller shaft by a helical, double-reduction gear with a ratio of speed reduction of 40 to 1.

The backing turbine is incorporated in the same casing as the ahead turbine, and when supplied with the same amount of steam as used for full-load conditions will develop not less than one-third of the full speed of the ahead torque on not more than one-third of the full speed revolutions per minute.

With dry, saturated steam at 185 pounds gage pressure at the throttle and 28 inches vacuum referred to a 30-inch barometer in the condenser, the steam consumption of the turbine when going ahead at 90 revolutions per minute of the main shaft and developing 1,500 shaft horsepower is not to exceed 12.5 pounds per shaft horsepower hour.

The thrust bearing of the Kingsbury type is incorporated with the low-speed gear and casing. The line shafting of forged steel is 10⅝ inches in way of the bearings and 10½ inches diameter elsewhere. The propeller shaft, also of forged steel, is 11½ inches diameter.

Each length of line shaft will have one or two spring bearings, depending upon the length of the shaft sections, with the bearings 15 inches long. The bearings will be of cast iron with a bottom section lined with white metal. Cast iron caps which will not bear on the shaft and which will be arranged for supporting the oil boxes will be fitted. A water service pipe will be fitted along the shaft tunnel with a spray pipe at each bearing.

The stern tube of cast iron has at each end composition bushings fitted with sections of lignum vitæ.

The lubrication of the turbine bearings and gears is by oil supplied by a gravity tank located in the engine hatch. This oil is supplied from the lubricating oil pumps, which draw from the drain tank underneath the gears and discharge through coolers to the gravity tank. Two oil coolers of ample capacity for cooling the lubricating oil are fitted. Water for the coolers is supplied by the main circulating pump and sanitary pump.

Engine-Room Auxiliaries

The condenser apparatus consists of a main cylindrical surface condenser having about 2,400 square feet of condensing surface, for which water will be supplied by a centrifugal pump with 12-inch suction and discharge, and having a capacity of 2,400 gallons per minute against a head of 15 feet. The circulating pump will be driven through gearing by a steam turbine.

The main air pumping equipment includes two turbo-driven, hot-well pumps and two Westinghouse Le Blanc air ejectors. The condensate pumps and piping are in duplicate, and each hot-well pump and air ejector is of ample capacity to maintain a vacuum under full power conditions. They are so piped up that any unit can be overhauled without interfering with the operation of the others.

Independent Pumps

The independent pumps comprise the following:

Two main and auxiliary feed pumps, vertical simplex, Westinghouse type, 9½ inches by 6 inches by 10 inches.

One ballast pump, horizontal duplex type, 10 inches by 10 inches by 12 inches.

One fire bilge and general service pump, horizontal duplex type, 10 inches by 6 inches by 10 inches.

One sanitary pump, horizontal duplex type, 6 inches by 5¾ inches by 6 inches.

One fresh-water pump, horizontal duplex type, 4½ inches by 3¾ inches by 4 inches.

One evaporator feed and ice machine condenser pump, horizontal duplex type, 4½ inches by 3¾ inches by 4 inches.

One auxiliary air and circulating pump, horizontal simplex type, 10 inches by 12 inches by 12 inches.

One oil transfer pump, horizontal duplex type, 7½ inches by 6 inches by 10 inches.

Two oil service pumps, horizontal simplex type, 4½ inches by 2¾ inches by 6 inches.

One auxiliary lubricating oil pump, horizontal duplex type, 6 inches by 5¾ inches by 6 inches.

Duty and Connections for Pumps

The duty and connections for the pumps are in general as follows:

The main air ejectors and condensate pumps draw from the main condenser and discharge to the feed and filter tank.

The main circulating pump draws from the sea and bilge and discharges overboard through the main condenser.

The main feed pump draws from the feed and filter tank and reserve feed tanks and discharges to the boilers either through the feed water heater or direct.

The auxiliary feed pump draws from the feed and filter tank, reserve feed tanks, and sea and bottom blows and discharges to the main feed line, auxiliary feed line, fire service and overboard.

The fire and bilge pump draws from the bilge main, engine room bilge, ballast main and sea, and discharges to the fire main, overboard.

The ballast pump draws from the sea, ballast main and bilge main and discharges to the main condenser circulating water, auxiliary condenser circulating water and overboard.

The sanitary pump draws from the sea and discharges to the sanitary system, water service and oil cooler.

The fresh-water pump draws from the engine room fresh-water tanks and reserve feed tanks and discharges to the fresh-water system.

The injector draws from the sea and reserve tanks and discharges to the auxiliary feed line. The evaporator feed pump draws from the condenser to discharge overboard and sea and discharges to the evaporator and ice machine condenser.

The auxiliary air and circulator pump draws from the sea and auxiliary condenser and discharges to the feed tank and overboard.

Auxiliaries

In addition to the pumps, the engine-room auxiliaries include a feed water heater of sufficient capacity to heat 25,000 pounds of feed water per hour from 90 to 212 degrees when using exhaust steam at 5 pounds per square inch gage pressure. It is specified that the drop in pressure of the feed water passing through the tubes shall not exceed 12 pounds per square inch.

A feed and filter tank of 800 gallons capacity is installed in the engine room. The feed tank is fitted with a float and a chronometer valve gear for automatically regulating the main auxiliary feed pump. A 2½-inch pipe is led from the feed tank to carry off vapor.

One injector of the double-tube type with 2-inch suction and discharge is installed with connections to draw from the sea and reserve feed tanks and discharge to the boilers.

An evaporator with a capacity of 15 tons in twelve hours is also installed.

The exhaust from all auxiliary machinery is condensed in an auxiliary condenser located in the engine room and having 800 square feet cooling surface. It is mounted on a combined air and circulating pump.

Development of the Diesel Type Marine Heavy Oil Engine in the United States

American Diesel Engine Builders—West Coast Activities—Economy and Reliability—Steam and Electrical Auxiliaries—Operation of the Engines

BY GEORGE A. COLLEY*

IN dealing with the development of the Diesel type of heavy oil motor for marine use in this country, a resumé of what has already been accomplished is necessary, followed by what is now being done to advance the industry and what will have to be done if it is to successfully compete with steam.

The west coast builders have undoubtedly done more for the rapid progress of the heavy oil engine in general than any other part of the country, by first installing auxiliary power in their large lumber carriers and then gradually overcoming the prejudice which they met everywhere and making them full motor powered ships.

Foreign Designs Adopted

Spurred on by the sight of foreign-owned and built ocean-going motorships in our ports, a few of our large eastern yards have made arrangements for building Diesel engines from foreign designs, while several other foreign-designed engines are now being built in various parts of the country.

The Navy Department has also gone into the field extensively, although to a much smaller extent than the foreign navies. At the same time, the installation in the fuel ship *Maumee* was one of the most radical steps ever taken to advance the Diesel engine in this country.

Navy Department's Investigations

At this writing it is, of course, impossible to give detailed results of the performance of this ship, but there can be no doubt but that our Navy Department will have at the end of the war an enormous fund of invaluable information on the Diesel engine of both high- and low-speed types.

There is also no doubt but that the close of hostilities will see the yachting interests of the country in the Diesel game to an increasing extent. The writer also believes they will lean to the full Diesel type of motor of fairly large power, as previous to the commencement of hostilities James Craig had powered several small yachts with an out-and-out American-built Diesel engine, while Alexander Winton has had a pair of V-type Winton Diesel motors in his own yacht *La Belle* for over two years.

Reduction Gears Introduced

Both of the above firms are in the commercial motor game to stay, and the Winton people have tripled their shop capacity within the past twelve months and have contracts ahead for over two years' work. The horsepower called for in these contracts ranges from generating sets of 60-kilowatt capacity to main engine units of 1,000 shaft horsepower. They have also introduced the reduction gear into their work, saving a tremendous amount of weight in the main engines by so doing for a given power and propeller speed.

In the large commercial sizes the prospective customer will find that the west coast engine builders are alive to the situation, as the Atlas-Imperial Company are building units up to 1,200 horsepower, and the surface ignition engine builders are pushing their product also. In the East, McIntosh & Seymour are prepared to build engines up to 1,350 horsepower, while both the Werkspoor and Burmeister & Wain motors can be contracted for from American builders.

Pacific Coast Motorships

The writer has recently inspected several motorships built at Portland, Oregon, by the Supple & Ballin Corporation, the Peninsula Shipbuilding Company and the G. M. Standifer Company. The first and last companies have turned out a strictly full-powered motorship, the Ballin ship being a 4,500-ton deadweight ship with two eight-cylinder, 500-horsepower Winton's direct connected, while the Standifer ship is a vessel of about 3,500 tons deadweight capacity, powered with two six-cylinder, 350-horsepower Winton motors geared three to one to the propeller shaft. Both of these vessels have steam-driven auxiliaries, except that the Ballin ship has an electric steering engine.

The Peninsula ships are of 2,300 tons deadweight, and are to be powered with two 350-horsepower Wintons, direct connected. They also are to have steam auxiliaries.

These vessels are representative types of what is being built throughout the Douglas fir district, and the workmanship throughout is of the best.

The various oil companies can be counted on to help things along, as they all have tried out various types of motor-driven ships with sufficiently satisfactory results to warrant further operations along the same lines.

Initial Errors Must Be Corrected

Mistakes have been made in the past which have retarded progress and created a distrust of the oil engine generally which will be hard to overcome, but a frank admission of errors and a willingness to correct them by builders both of hull and machinery will do much to help matters.

These mistakes and their remedies, also the various other points bearing on the building of a substantial foundation under the American motorship trade, the writer proposes to discuss in their relation to the various interested parties, namely, the owner or operating company, the operating engineer, the engine builder, the installing yard and the naval architect.

The owner, or operating company, has certain conditions which must be fulfilled. His requirements are that his installation shall be reliable, economical, both as regards running expense and upkeep, easy of repair and of reasonable first cost. He also must be assured that his auxiliaries will be taken care of properly.

Reliability the First Consideration

Regarding reliability, the average owner does not care to experiment at his own expense, and the engine builder should be prepared to meet him more than half way in regard to terms, guarantees, etc., and once having done so, to follow them up with the same amount of zeal that was used in obtaining the order.

* Tams, Lemoine and Crane, naval architects, New York.

The owner will also want to know if the particular size of machine he intends using has ever been built before. At present the average answer will be negative, as the average builder in this country has not had time to experiment on a machine of each of the various sizes he intends building. One builder has adopted a practice of building a single-cylinder machine of each size and obtaining data therefrom. This is a move in the right direction, as there has been too great a tendency toward selling machines regardless of their suitability for the work.

Fuel Economy

As regards fuel economy, the Diesel type has a tremendous margin over the best steam practice, but in many installations the lubricating oil cost reduces this margin to a very large extent. A carefully worked out system of filtration and cooling for re-use of the lubricating oil will help materially.

Upkeep and ease of repair are vital. The repair bills and layoffs due to engine trouble must be reduced by careful attention to detail. Ease of repair can be furthered to a great extent by careful attention to the location of accessories and auxiliaries, as half of the repair expenses in many cases are due to the time taken to remove and replace piping and other gear in no way connected with the trouble, but so in the way that nothing can be done with them in place.

Regarding reasonable first cost based on power delivered, fair competition will probably take care of this question automatically.

Auxiliaries—Electric Installation Ideal

The question of auxiliaries is one which many of the engine builders have overlooked to a large extent. Two general schemes present themselves for consideration, and the Diesel engine salesman should be well posted on both before attempting to talk business. They are, first, the straight steam-driven auxiliary installation supplied with steam from a donkey boiler, which should be a real oil-burner, not a makeshift, and, second, the electric-driven installation with oil engine-driven generating sets. Probably the electric installation properly worked up with breakdown sets for emergency use and a small watertube, oil-fired boiler for heating, hot water service, etc., would be the ideal installation.

Above all things in the auxiliary proposition, give the owner enough power. Many of the smaller motorships at present are using the old-fashioned inefficient firetube donkey boilers of just capacity enough for the winches when the latter are new. After they have been in commission a short time there is a continual loss of time when loading and unloading, which, under present conditions, is nothing short of criminal.

Steam Auxiliaries

A ship equipped with steam auxiliaries should be fitted with condensing and evaporating apparatus for make up. The writer also believes that a carefully worked out system of fresh-water cooling for the main engine would be well worth a trial.

Proper attention should also be paid to adequate bilge and fire service, electric lighting, etc. Possibly the engine builder will think these matters out of his province; but they are the questions which the owner will ask, and if he is met by answers that indicate the engineer's knowledge of his subject much will be gained.

The operating engineer is more properly interested in the improvement of fuel handling devices, attention to lubrication problems, and the like. The writer believes that most of the builders will do well to bring into use many of the standard strainers, filters, coolers, and the like, now on the market for fuel and lubricating oils, rather than to attempt to go all over the work of the very competent engineers who designed them. The writer has seen filters and strainers for use with Diesel motors which are crudities compared with the accessories used in steam practice.

Trained Operating Engineers Badly Needed

Efficient operating engineers are at a premium and oil engine manufacturers generally would do well to take a leaf from the books of some of the largest and most successful machinery manufacturers. These latter have schools for their embryo salesmen where they learn every detail of the machinery right in the shops, so that when sent on the road they are capable of selling, erecting and making the initial run of the machine. Some such scheme used with regard to engine crews would soon give us a set of men who would be boosting the game and not knocking it.

The engine builder has some very strong opinions with regard to owners and operating engineers generally, not without a good deal of cause. Many owners seem to think that because their machinery is oil-driven almost any sort of an engineer can run it, when, as a matter of fact, at this stage of the business it will take the closest kind of co-operation between builder and engineer to make things run smoothly.

Builders Should Do More Than Supply the Engines

The builders will also do well to follow the methods of the large marine turbine manufacturers, who are always at the disposal of their customers for information of all kinds having a bearing on their installations. They are never content merely to sell their main units, but always make it a point to know whether the rest of the equipment, and even the ship itself, will co-ordinate with what they are furnishing to make a perfect whole.

The installing engineer, or shipyard, also has an extremely important part in the success of the outfit, more particularly so with regard to a full Diesel installation than with the surface ignition type. The high pressure air lines must be installed with the greatest care, which means constant watchfulness in these days of green workmen and rush jobs. These lines should be as short as possible and the whole layout should be as simple as conditions will allow. This same thing applies to the entire main engine and auxiliary installation.

What the Naval Architect Can Do

The naval architect's connection with the advancement of the Diesel engine should be along the lines of the careful and accurate co-ordination of all the before-mentioned points. It should be his duty to impress on engine builders the necessity of obtaining proper engine speed for any particular type of ship. Underpowering and lack of attention to auxiliaries or other details will do much to slow up progress.

In conclusion, no time was ever riper for the advancement of any industry than is the present time for the advancement of the motorship. With the New York State barge canal about to open for traffic, and, in fact, all the inland waterways and coastwise trade of the country in need of motor-driven craft of all kinds, experience along these smaller lines can be gathered to such an extent that when hostilities cease the motorship should have no difficulty in giving the steamship the race of its life.

In some ships the bilge gets more oil than the engine.

Fig. 1.—185-Foot Schooner *Dornfontein*, in Frame on January 29, 1918, Will Be Fitted with a 250-Horsepower Kahlenberg Oil Engine

Motorships and Their Propelling Machinery

Six Classes of Vessels Being Equipped with Internal Combustion Engines—Typical Designs—Rapid Development of Motorship Inevitable

BY J. MURRAY WATTS*

THE use of the internal combustion engine using oil fuel has lately increased to a very considerable extent, and has become a formidable rival to the steam engine in practically all vessels where powers of under 10,000 horsepower can be employed. The liner, the battleship and the destroyer are about the only three types of ships in which the oil engine has not been applied. The high-speed turbines and watertube boilers of the destroyer are far less in weight per horsepower than Diesel engines, and in the case of larger ships even where the item of keeping down the weight is not the greatest essential, oil engines have not been built in sufficiently large units to give satisfactory service.

This narrows the field of the oil-engine-propelled vessel down to six classes of vessels, i. e., the submarine, the bulk freighter, the small passenger boat, the shoal-draft river boat, the motor tug and the yacht. In this article we will not discuss the submarine at length, as a technical description of our new boats is not advisable in time of war, and the main details of the latest type of Austro-German submarines are pretty generally known; the class *U*-21 to *U*-32 having a surface displacement of 650 tons, displacement submerged 800 tons, length 213 feet 3 inches, brake horsepower, Diesel engines, 1,800; brake horsepower, electric motors, 800; maximum speed, surface, 16 knots; submerged, 10 knots; radius, surface, 1,500 miles; torpedo tubes, four, with 18-inch Schwatz Kopf torpedoes; guns, two of 2.46-inch caliber. The latest types, from *U*-33 on, have Diesel engines, 2,500 brake horsepower, and 5.9-inch guns.

Fig. 2 shows the plan of a 213-foot submarine with a special life-saving device developed by the author, according to the "Pointiere" patents.

Fig. 4 shows an up-to-date type of steel motor vessel now being designed by this firm, 424 feet long over all, 406 feet between perpendiculars, 54 feet beam, 37 feet depth and 25 feet 6 inches normal draft, corresponding to 12,000 tons displacement. The power is furnished by two Diesel engines of 1,600 horsepower apiece, with the normal revolutions of 128 per minute, which gives 11¾ knots under full load conditions. A steam freighter of this class would be propelled by a single screw, and would have somewhat greater efficiency owing to a larger propeller and slower speed of revolutions, say 80 revolutions per minute. In practice, the Diesel engine installation has several advantages, in spite of the extra weight and resistance of the spectacle framing and smaller screws. The fact that smaller propellers are used means that, whether the vessel is in loaded or light condition, their immersion is proportionately greater; consequently in heavy weather there is no danger of the engine racing, and the engineer on watch does not have to stand ready to throttle down when the stern lifts.

* Naval architect, 328 Chestnut street, Philadelphia, Pa.

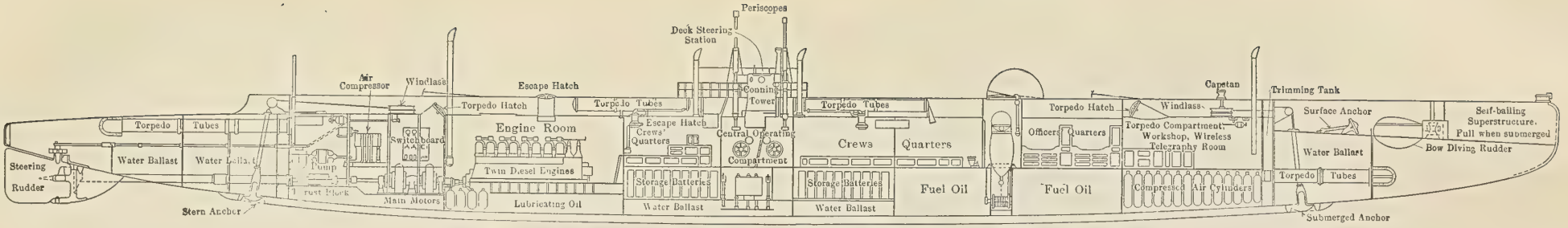


Fig. 2.—Profile of 213-Foot Submarine, Equipped with Special Life-Saving Device

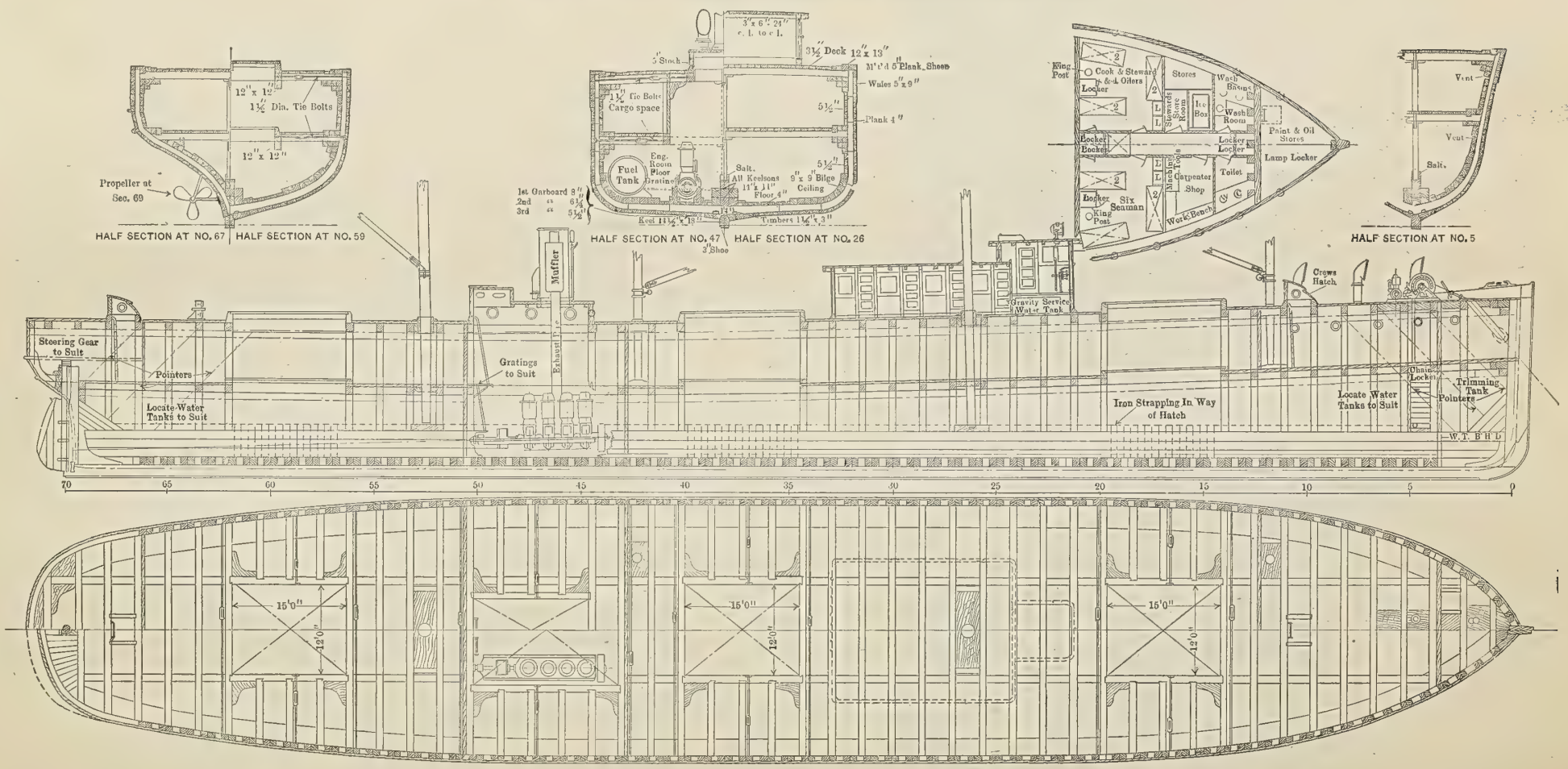


Fig. 3.—Construction Plans of 200-Foot Wooden Motorship of 1,500 Tons Deadweight Carrying Capacity Building for East Indian Trade

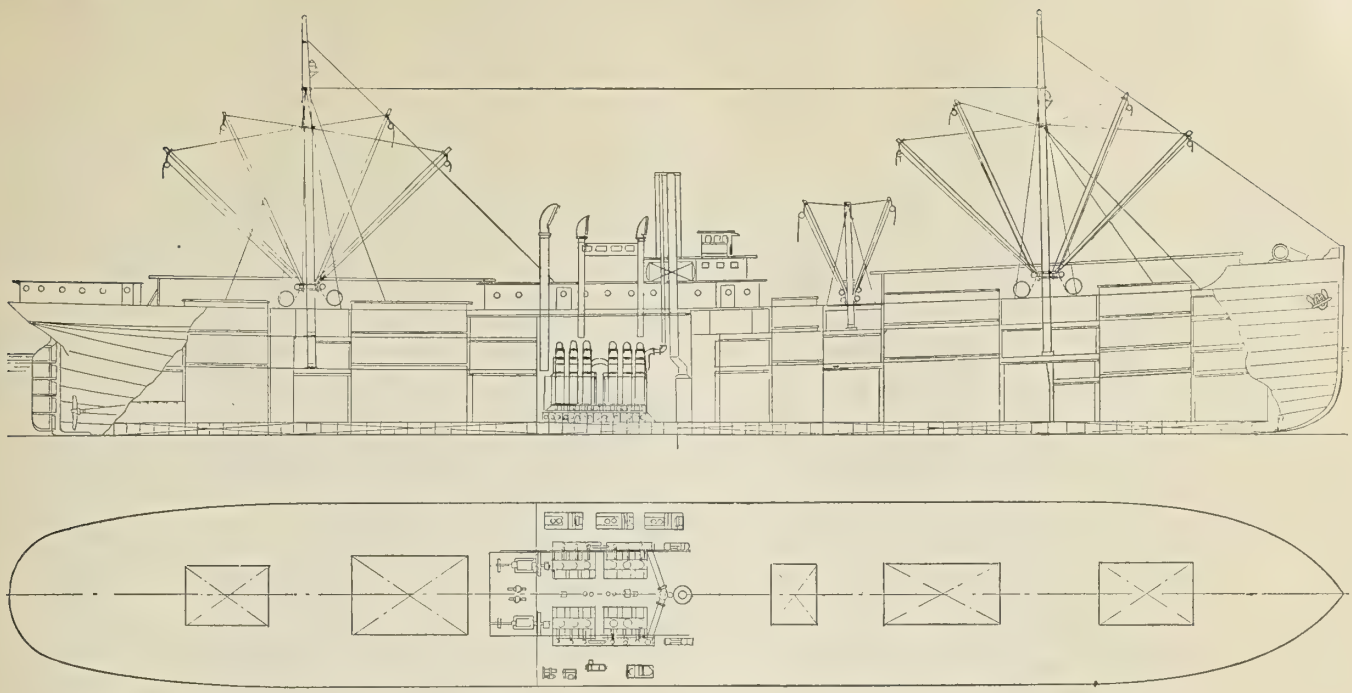


Fig. 4.—Design of Motorship of 12,000 Tons Displacement Propelled by Two 1,600 Horsepower Diesel Engines

On a long voyage the absolute uniformity of the revolutions of the Diesel engines makes up in a large degree for the greater theoretical efficiency of the larger and slower propeller on the steam engine. The saving in weight of the propelling machinery on this size ship is about 129 tons over that of a steamer. The length of engine-room space occupied by the motor installation is 49 feet, about 20 feet less than would be required for the steam plant. According to the latest practice, the fuel oil is carried in the double bottom, and this amounts to nearly 1,200 tons, giving a steaming radius of 29,000 miles. Owing to the saving of machinery space, there is about 20,000 cubic feet saved for cargo over that of a steam vessel, giving an additional earning capacity of about 10 percent. If the steamer burns coal its engineering force would be considerably greater. If the steamer has oil-fired boilers the engineering force would be about the same, as there would be twin engines to look after on a motor ship and a single engine on a steamer. An oil-burning steamer would use somewhat cheaper fuel oil and have less expense for lubricating oil, but the economy in the consumption of the Diesel ship is so great that a saving of about 80 cents (3/4) a mile would be realized on a round trip from Boston to Montevideo, for example, amounting to $9,600 (£1,970).

Wooden Motorships

Owing to the difficulty in getting deliveries of ship plates, many wooden-hulled vessels are being built. Most of the American wooden motorships, a large proportion of which are built in the Southern and Pacific States, have been widely described and illustrated in all the recent marine publications, so I will confine myself to individual types of motor vessels, most of which have been designed for foreign owners. The following plans will illustrate my meaning:

Fig. 3 shows a class of oil-engined wooden cargo vessels, 200 feet long, now building by Pyne, Hughman & Company, Ltd., Calcutta, India, from the author's designs. They will be used in the East Indian trade. These vessels have two full decks and about 1,500 tons carrying capacity. They are being built to Lloyd's highest class, giving them a rating of 16 years, their construction being teak throughout, reinforced with steel cross strapping.

The motive power is furnished by twin-screw engines of 500 horsepower, and a fuel supply sufficient for 4,000 miles. A complete installation of electric and pumping auxiliary machinery is fitted, also a four-ton ice-making machine for furnishing refrigeration in the tropics. The windlass and cargo winches are also driven by oil engines. There are six cargo booms, two on the mainmast and one on each of the four king posts. There are three large cargo hatches, each 12 feet by 15 feet. The accommodations for the crew are unusually good, the officers being berthed in the deck house and the crew in the forecastle. The general dimensions are: length, 200 feet; beam, 35 feet; depth of hold, 17 feet 6 inches.

Shallow Draft Oil and Cargo Motorships

In the January issue of Marine Engineering, page 10, were shown the plans of a fleet of oil tankers for use on the Volga River, building by the Nobel Brothers Company, of Petrograd, Russia. As the Nobel Brothers Company have their own shipyards and their own factories are constructing the Nobel-Diesel engines, they are unusually well equipped for the construction of steel vessels of this type. The great difficulty of navigation on the river Volga is the fact that during periods of low water the deepest draft vessel that can be utilized in certain reaches of the river is limited to 7 feet, and the interesting problem arose to design self-propelled steel vessels of large capacity, with this light draft, that would have a speed when loaded of 12 miles.

The general dimensions are: length, 432 feet; beam, 64 feet; depth, 14 feet, and draft, loaded, 7 feet. The vessels are constructed of mild steel. The oil cargo is carried in bulk in the deep, double bottom and expansion trunk. There are four main propelling engines of the Nobel-Diesel type, each of 750 horsepower, and each driving a three-bladed bronze propeller 80 inches in diameter and 80-inch pitch, at a rate of 225 revolutions per minute, giving a speed of 12 miles loaded, and about 14 miles light. There are three rudders hung outboard, actuated by a Dake steering engine aft, and controlled

from the pilot house forward. Besides the 3,500 tons of cargo in the shape of petroleum in bulk, there are tanks for fifty tons of fuel oil for the main engines and auxiliary engines.

A fleet of motor vessels is also building by the Nobel Brothers Company, of Petrograd, Russia, of even less draft than the oil tankers, which can navigate the shallow tributaries of the Volga. These vessels carry oil in barrels in a large cargo box on the main deck. The oil is brought from the oil fields to the main distributing centers on the trip up river, and lumber and other bulk cargoes are loaded into the cargo box for the return trip. This class of boat is 325 feet long, and on account of the shoalness of the upper Volga River is restricted to 5 feet draft loaded. This vessel carries 1,500 tons of oil in barrels, besides 20 tons of fuel oil. They are quadruple-screw boats driven by four 450-horsepower Diesel engines driving propellers 58 inches diameter and 58 inches pitch, and giving a speed loaded of 12 miles.

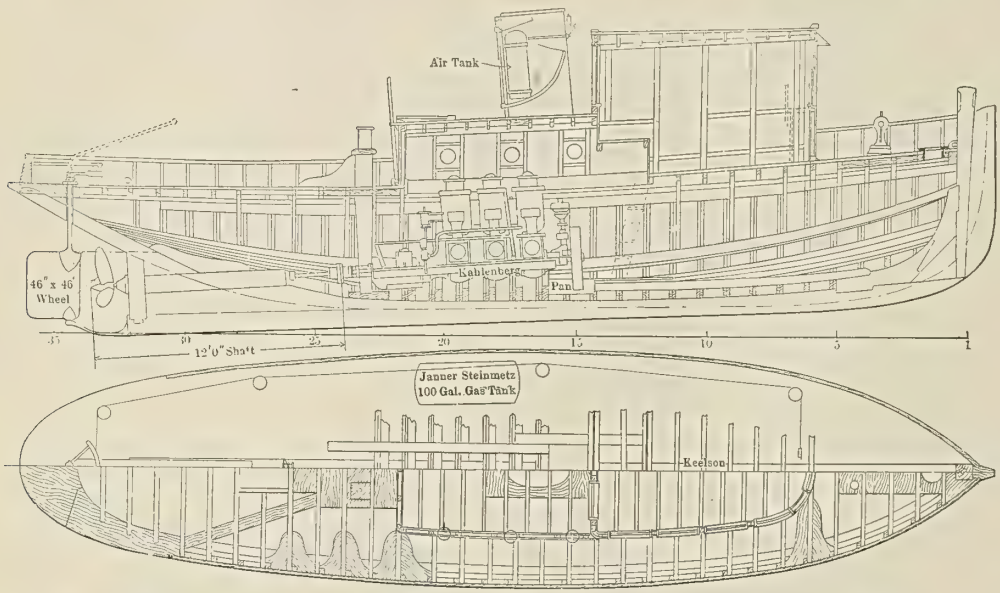


Fig. 5.—Wooden Motor Tugboat Equipped with 90-100 Horsepower Kahlenberg Engine

Auxiliary Motor Schooners

On page 485 of the November, 1917, issue were shown plans of the four-masted schooner *Dornfontein,* now being constructed by the Marine Construction Company, of St. John, N. B., Canada. This boat is now in frame, and the keel of a duplicate will shortly be laid. The general dimensions are: length over all, 185 feet; keel, 160 feet; beam, extreme, 40 feet; depth of hold, 14 feet; molded depth, 15 feet 8 inches. The vessels are constructed to the latest requirements of the American Bureau of Shipping, and utilize as far as possible the timber available in New Brunswick, the keel being of fir 14 inches by 22 inches, with a 4-inch birch shoe, her timbers being birch below the waterline and black spruce above, sided 11 inches double and molded 14 inches, spaced 27 inches. The keelson consists of three tiers on each side, of 14-inch by 14-inch British Columbia fir. The deck beams are also 14-inch by 14-inch British Columbia fir, spaced 3 feet 6 inches apart.

The planking varies from 7 inches to 4 inches in thickness, the under-water portion being birch and the topsides being 4½-inch black spruce. The decking is of 3½-inch spruce. Practically all the deck joiner work, houses and hatches, will also be of spruce. The masts, however, will be of Oregon pine, the foremast being 25 inches in diameter and the other three masts 24 inches in diameter; all 84 feet in length; the topmasts are 48 feet 6 inches long, and will be of spruce, as will be the other spars, with the exception of bowsprit, jib boom and spanker boom, which will be of Oregon pine. The engine for the first one of these boats will be a 250-horsepower Kahlenberg oil engine. The engine for the second schooner has not yet been dcided on.

The 150-foot wooden auxiliary schooner *Jose Juan Domine,* building by the Valencia Ship Building Company, of Valencia, Spain, for Romani y Miquel, of Valencia, Spain, will be used in trading between Valencia and the Spanish-African colonies, and is adapted for carrying barrels of wine, raisins, etc. She has a cargo capacity of about 450 tons and is propelled by a 200-horsepower Diesel engine. The vessel is built throughout according to Lloyd's requirements, and is rigged as a three-masted schooner. Besides the main propelling engines, there is a complete outfit of auxiliaries, including a 35-kilowatt electric plant, which operates the electric capstan and electric winches. This vessel was illustrated and described in the March issue of this journal, page 91.

Motor Tugboats

Fig. 5 is a good example of an oil-engine tugboat. Two of these boats are now being completed at the yard of L. D. Steel, Delanco, N. J., for the Republic Mining and Manufacturing Company, of Philadelphia. Each of these boats is equipped with a 90-100-horsepower Kahlenberg heavy oil engine, which turns a 46-inch by 46-inch three-bladed propeller at 350 revolutions per minute. These boats are intended for the heaviest class of work, being built of oak throughout, and will be used for towing 500 tons of bauxite, which is the name of the ore from which aluminum is taken, in barges from the company's mines to Georgetown, British Guiana, South America.

The general dimensions are: length, 47 feet; beam, 12 feet; draft, running, about 4 feet 8 inches. They were shipped down the latter part of February on board one of the company's steamers. These tugs are an improvement over a similar class of tug recently shipped to Demerara, for the same company, which were also designed by the author, but powered with a 75-horsepower Standard gaso-

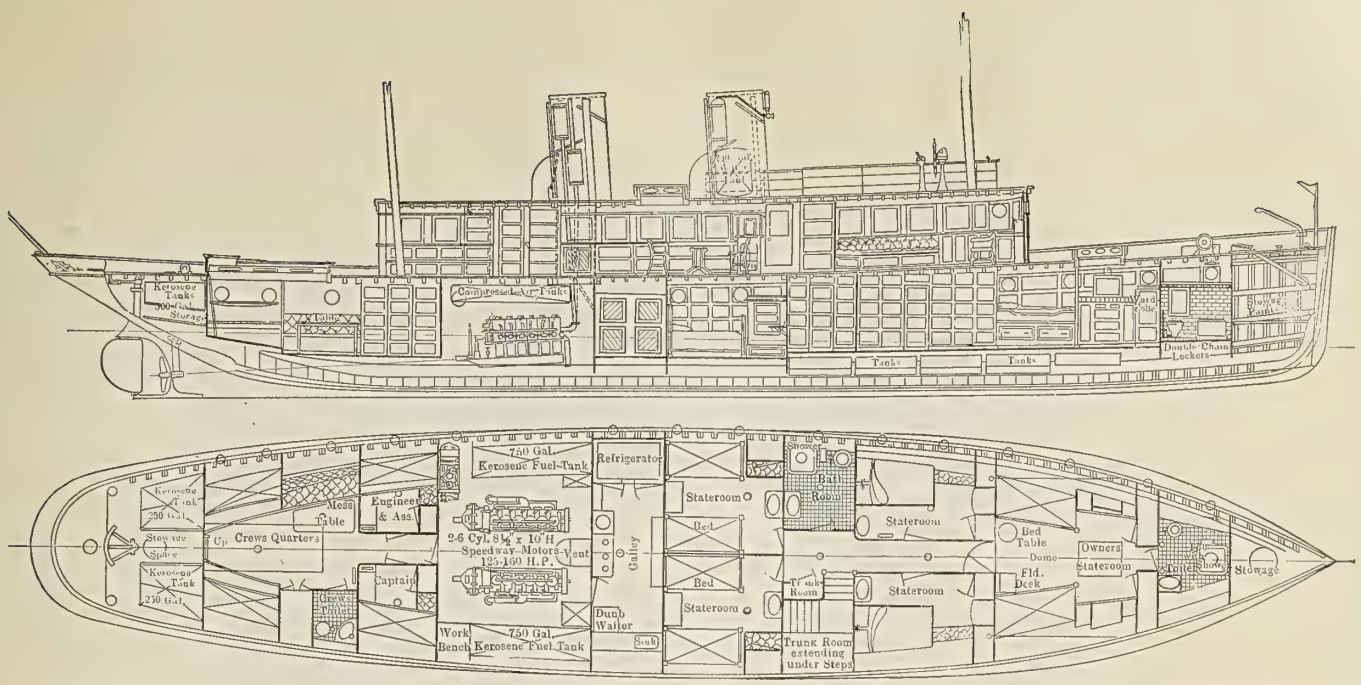


Fig. 6.—110-Foot Oil-Engined Yacht *Consuelo*, Recently Built to Author's Designs

line (petrol) engine. This engine was also equipped for burning kerosene (paraffin), but, owing to the high price of gasoline (petrol) and kerosene (paraffin) in South America, it has been decided that the tugboat fleet for this company shall in future use heavy oil engines, which can use the local fuel oil and effect a great saving in running expenses.

A combination freight and passenger boat now greatly used in South America is the *Sinu*, a 95-foot, shoal-draft, working boat (see page 487, November, 1916, issue), which has been built by the Cartagena Shipyard, from the author's designs, for Mr. F. A. Scharberg, of Cartagena, Colombia, S. A. The dimensions are: 95 feet over all, 90 feet waterline, 20 feet beam and 4 feet 6 inches draft. The engine consists of a 100-horsepower, heavy-duty Bolinders oil motor. The boat is used for transporting cargo and passengers up and down the river from Cartagena, Colombia. There is a good-size saloon for passengers in the deck house and plenty of room for cargo in the forward and after holds.

Fig. 6, the 110-foot cruising yacht *Consuelo*, is a good type of oil-engined yacht. This boat was recently built by Geo. Lawley & Son Corporation, Neponset, Mass., for J. Percy Bartram, of New York. The general dimensions are: 110 feet over all, 102 feet waterline, 21 feet beam, and 5 feet 8 inches draft. This boat shows the general tendency of the large motor yacht to get the accommodations of a houseboat with the seaworthiness and shippy appearance of a seagoing vessel. The engine room is just aft of amidships. In it are installed two 160-horsepower Speedway oil motors, a 4-kilowatt electric plant, the auxiliary plant, tanks holding 2,200 gallons of fuel and 100 gallons of lubricating oil. The crew's quarters are unusually spacious, there being bunks for five paid hands, and a mess room, crew's toilet and two staterooms, one for the captain and one for the mate and engineer.

Concrete Motorships Being Designed

Owing to the difficulty of obtaining material for the usual form of ship construction and the scarcity of skilled ship carpenters, a new type of craft is now being tried out in the oil-engine field, and this is the concrete vessel. Fig. 7 shows the general arrangement plan of a fleet of inland waterway motor-propelled freighters now being designed by the author for a New York shipping firm. These boats are 150 feet long, 21 feet beam, and have a draft when fully loaded of not over 6 feet, so as to enable them to go through the Delaware and Raritan Canal. They are propelled by 60-horsepower Mietz & Weiss oil engines. The freight is carried on deck and is brought aboard by

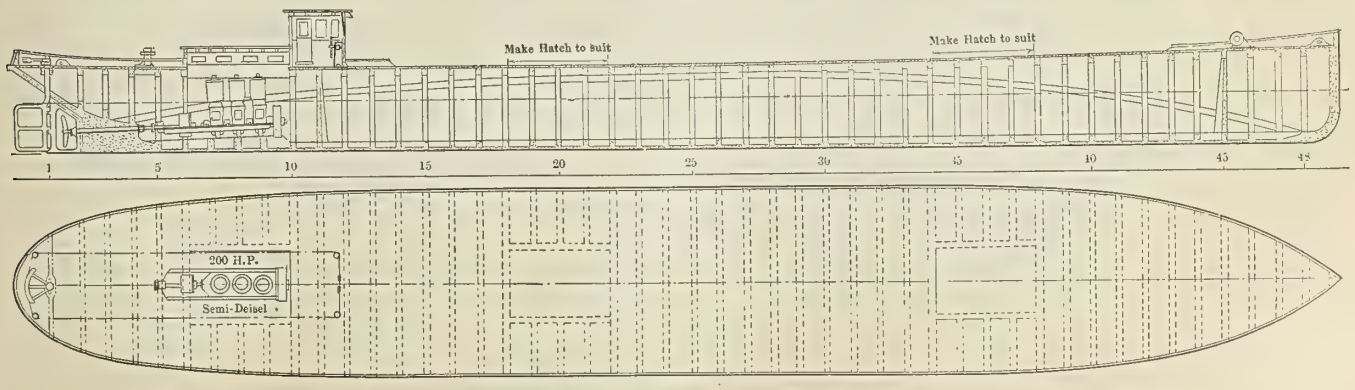


Fig. 7.—Reinforced Concrete Motor Freighter. Length over all, 150 Feet; Beam extreme, 22 Feet; Beam molded, 21 Feet; Load draft, 6 Feet

means of trucks. For this purpose the deck is kept absolutely clear, except for the power windlass forward, and the pilot house and engine room trunk aft.

The chief advantage of these boats is that they only require between 35 percent and 40 percent of the amount of steel used in a steel vessel of equal carrying capacity. Their disadvantage is that the weight is about 80 percent greater for seagoing vessels and about 65 percent greater for canal work and use in sheltered waterways. Through the employment of a rich mixture of cement and suitable waterproofing material, the hulls can be kept practically impervious to water. From an engineering point of view, the main structural strength in tension is taken up by round bars of steel, which vary from ½ inch to 1¾ inches in diameter, embedded in the concrete, the power of adhesion between the steel and concrete being increased by the irregularities of the bars. The stresses in compression are largely taken up by the concrete itself.

Owing to the greater weight of the concrete hull, it would naturally seem that considerably greater power would be needed to propel them than with the lighter steel hull. Part of this loss is offset by the fact that the surface of the concrete can be finished smoother than the steel hull, and also very good lines can be easily given these vessels, together with the absence of the box-like, parallel middle-body so often employed with steel shapes for the sake of economy in framing and plating and ease in construction.

This covers pretty thoroughly the present state of the art as applied to motor vessels, but there is no doubt that after the war we will have a very rapid development in the size of Diesel engines, so that eventually they will be employed in the largest type of ships. In Germany, before the war, some very large experimental engines were constructed at the Krupp Works, one of them developing as much as 1,500 horsepower in a single cylinder. Considerable difficulties were experienced from the intense heat causing internal stresses in these large castings, but when these difficulties are overcome it is easy to see that a six-cylinder engine of this type would develop 9,000 horsepower or 18,000 available horsepower for the ordinary type of twin-screw ship.

American Classification for American Ships

Regulation of Shipbuilding and Insurance of Vessels Must Be in American Hands to Preserve Our Merchant Marine

BY WINTHROP L. MARVIN

A SPECIAL committee on merchant marine of the Boston Chamber of Commerce, in a recent report addressed to the Senators and Representatives in Congress, emphatically set forth as "one essential of complete success in American shipbuilding and navigation," "a thoroughly American inspection, survey and classification service, capable of performing for the United States a work which Lloyd's has long rendered for the British Empire."

Now the time has come for a vigorous reassertion of this fundamental truth that the new American merchant marine which the emergency of the war is creating will inevitably fail of its ultimate purpose and decline and disappear from beneath our flag, if the regulation of our shipbuilding and the insurance of our ships are to be left to alien concerns pledged to promote the interests of other peoples and of other governments. As this Boston report declared:

"For many years American shipowners and merchants, even in the coast and lake trade, have been largely dependent for marine insurance upon foreign corporations. To realize the full benefits of an independent American shipping industry, it must be possible to effect adequate insurance in companies domiciled in the United States, preference being given by our shipowners and merchants to insurance in American companies, and to this end a strong classification society must be at once established, so that American insurance interests can undertake marine risks with all proper safeguards and necessary information. There is abundant capital in this country, and abundant technical and administrative skill, and they should be brought into effective co-operation."

During the earlier years when American sailing clipper ships and steam mail lines were pre-eminent in ocean traffic and the Stars and Stripes flew on all seas, our country was not beholden to any foreign land for its marine insurance. Satisfactory inspection and underwriting were available in our own land; in this most vital element of maritime strength we were prepared and independent. The Civil War, and the ravages of the Anglo-Confederate cruisers—built, fitted out, largely manned in England, as history records—dealt a heavy blow to our resources in this direction.

How Our Underwriting Was Lost

Gradually, as we lost most of our merchant ships, our insurance resources shrank and vanished with them. Or, as a veteran observer has described it:

"The United States has fallen behind in underwriting, not for the want of capital, but because Amerian insurance business has been undermined through the decay of our marine and the consequent extinction of American mercantile houses and genuine American commerce with foreign nations. It cannot be expected, as a practical thing, to have underwriters without merchants, merchants without ships, and ships without shipowners and builders, as these branches all belong to the same tree. When you admit a foreign merchant, you let in his ship, his underwriter and his shipowner, and there is a great growl by all his friends, new as well as old, because the door is shut to his shipbuilder; for his desire is to employ all his own people, in preference to ours, even after he has grasped, and controls, our trade."

Origin and Power of Lloyd's

All of this is true, as all men know who know the past course of American shipbuilding and navigation. Nearly a century ago, in the year 1834, a committee of British shipowners and underwriters, men of a class whose historic rendezvous had been Lloyd's coffee house in London, agreed "to establish a new society for the purpose of obtaining a faithful and accurate classification of the mercantile marine of the United Kingdom and of foreign vessels trading thereto." There can be no objection to a "faithful and accurate classification," but as Lloyd's grew

in scope and power this is just what it has not given to the ships of Britain's most enterprising and most feared competitor.

The influence which British inspection, survey and insurance laws and methods have had upon the American merchant marine has been adroitly and persistently unfriendly and repressive, and it would be the height of national folly to permit this to continue when the time and the occasion have now come to put an end to it forever. The great American shipbuilder and shipowner is now the Government of the United States—the greatest shipbuilder and shipowner in existence. The largest fleet owned under any single corporate control in Europe is a pigmy besides the 9,000,000 tons which the Federal Shipping Board has requisitioned or is constructing. But under the law creating it the Shipping Board is holding this huge merchant fleet only temporarily, as a trustee for the American people, with the avowed purpose of transferring it to citizen owners to be operated by private enterprise as soon as possible after this present war has ended. And the Shipping Board is under obligation to arrange for the inspection and insurance of these hundreds of American ships in such a way that after the war they can remain under the American flag as carriers of peaceful commerce.

They will never so remain if the classification which they will bear and the rate of insurance required—which practically fixes the freight rate they can command, and, indeed, determines whether they can obtain cargoes the world around—are to be left to the whim of men or organizations of the nation which will certainly be our chief antagonist. The vast power of Lloyd's encircles the globe. Great Britain has controlled five-eighths of the carrying trade of the world, but monopolizes seven-eighths of the sea insurance, and has a record of wielding this tremendous weapon relentlessly for her own advantage.

Let Us Learn From Experience

Let us turn back to some illuminating chapters of our own maritime experience. Those British-built "privateers" of our Civil War, as has been said, struck American ocean shipping a hard blow, but did not kill its spirit of enterprise and perseverance. When that war closed, subsidized British mail lines securely held nearly all the chief trade routes of the world, and the speed of our clipper sail ships could not prevail against them. But there were still some long-voyage trades where passengers were few but cargoes heavy and valuable, which steamers could not yet undertake. One of these, and the principal, was the export trade of grain from the fertile States of our Pacific coast to Europe.

There was then no Panama Canal or Tehuantepec isthmian railway; the route lay around Cape Horn, and it was a voyage of 13,000 to 14,000 miles, or four or five months, from Puget Sound, the Columbia River and the Golden Gate to Falmouth, Queenstown, Liverpool, Havre or Antwerp. Grain was a bulky, shifting, hazardous cargo, and the character of this commodity and the length of the run compelled the use of large, strong, seaworthy vessels, the best carriers of the chief maritime nations of the world.

The Great California Grain Trade

It was not a trade for steamships; the distance was too great and the cost of coal too high. It was the special field of the great square-rigged ships and barks of a substantial type, which had succeeded the clippers of an earlier generation. When the Civil War was over, the shipbuilders and shipowners of New England and New York, undaunted by their losses, laid the keels of a new fleet of the finest wooden sea carriers that ever floated. Stancher and more durable than the flying racers of the two decades before 1861, they were powerfully constructed of the best of oak and hard pine, on models less sharp and extreme and yet symmetrical, skillfully combining great cargo room with unusual speed. These were the "medium clippers," the characteristic deep sea American sail ships of the period from 1865 to 1890. They were built for the California grain trade and they were of far more than average size, ranging from 1,200 to 3,000 tons gross register.

They embodied a new challenge to the maritime asendency of Great Britain. How were they met—in a spirit of free and equal competition? Not at all. The British Lloyd's struck them an unfair blow almost at once by arbitrarily refusing, in 1870, to "class"a wooden ship for more than a year at a time, and Lloyd's Register and the British underwriting companies combined to discriminate most unjustly against these splendid new American square-riggers and to drive them from the ocean.

Our Ships Largest and Best

All the details cannot be related here. It was a sharp struggle and a long one, graphically set forth in several chapters of that painstaking work, the "American Marine," by the veteran Captain William W. Bates, former United States Commissioner of Navigation. Captain Bates tells how in the seventies and the early eighties Americans and Britons fought for the mastery of the California grain trade, and around-the-Horn trade, the noblest field of maritime rivalry and the severest school of seamanship. Of the American competitors a few were of iron; most were of wood. Of the British craft nearly all were of iron. The Americans were, as a rule, the largest vessels, averaging between 1,600 and 1,900 tons, while of fourteen great ships of above 2,000 tons that sailed from the coast for Europe in 1880-1881, twelve were New England-built. The average tonaage of the British iron ships was less than 1,400.

From a close analytical study of voyages, Captain Bates shows that the American ships in this Pacific trade bore off all the honors of actual performance. They made their passages around the Horn to Europe in time averaging five days less than the British iron ships. The Americans met with fewer accidents and called on the underwriters for fewer losses; only one American vessel out of 212 was wrecked, while of British vessels the record was one out of 88. The American ships delivered their valuable cargoes in the best condition. On the basis of actual achievement, the American grain fleet in those years of memorable rivalry should have had the lowest insurance rates and the highest freight rates. That was incontestably the due of the Stars and Stripes, as established by our incomparable builders and seamen.

How American Ships Were Driven Out

As a matter of fact—Captain Bates relates the whole story—the British Lloyd's Register and the British underwriters in collusion for the upholding of British interests at any cost, forced the American ships to pay the highest insurance rates and to accept the lowest freight rates, the discrimination amounting at times to more than 20 percent. These cargoes of American grain were sold principally to British merchants and ships and cargoes were insured in British companies—there were relatively few American underwriters on the Pacific coast. Thus a deliberate and hopeless handicap was laid upon American shipping, and gradually these splendid vessels, in the prime of their strength and efficiency, were driven by the

tyrannical power of Lloyd's from European trade and forced to seek shelter in the protected coastwise service.

In the period from 1881 to 1885, one hundred great American ships had sailed every year in the grain trade from San Francisco to the United Kingdom or the Continent. In the year 1889—so well had Lloyd's done the work expected of it—only 30 American ships sailed in this trade, as against 167 British vessels. Though the American ships were compelled by Lloyd's discrimination to accept a freight rate 15 percent lower than foreign ships, the 30 Americans made the long voyage to Europe in an average of 113 days, as compared with the 131 of their favored British competitors. In that year, 1889, only one square-rigged ship was built in the United States; Great Britain still had hundreds of large sail craft afloat. A surer way than the *Alabama's* had been found to destroy American ocean commerce, and that long before steam had come to dominate Pacific carrying.

When, some years later, an American shipbuilding concern on the Delaware River sought to send machinery from Wilmington to Puget Sound to establish an iron shipyard and machine shop there, both the machinery itself and the steamer that conveyed it were denied insurance by the foreign underwriters—their mastery of the situation had become almost complete.

A Sinister Alien Monopoly

Well does Captain Bates declare:

"Foreign underwriters do, and always will, prefer to cover the commerce, and serve the interests, of their fatherland. Partiality goes with their allegiance. As clever rivals make unfit agents, so foreign underwriters cannot equally serve two nations. No wise nation will commit its commerce to the insurance powers of rival countries, because to trust foreigners, in place of our own people, is to be betrayed at last. We may as well have our shipyards closed, as our insurance offices shut up, since we should expect the same result to follow, namely, helpless foreign dependence in a vital branch of business. It is needful to know only the history of their hateful grasping of our trade and transportation to understand fully, if we become dependent on the British Lloyd's or other English underwriters for marine insurance, on that day our competition with British shipping is at an end."

This whole question of classification and survey and of marine insurance has now come again to be a very live question with the American people and their government. We have a record of what the British Lloyd's and British underwriters have once done, and they will do the same thing once more if we are blind and infatuated enough to give them an opportunity. Lack of knowledge of the past, or a most deplorable lack of caution, has admitted Lloyd's to a part in the inspection and classification of the new steel ships now building in this country for the United States Shipping Board. Some of these vessels were ordered for foreign owners, but have now been taken over by our government and are destined to fly the Stars and Stripes. There can be no possible excuse for a continuance of any control over these government-owned American ships by a wholly and intensely foreign organization like the British Lloyd's, or for the surrender to it of any supervision whatsoever over new American ships yet to be constructed.

Need of More Wisdom Now

The special committee on merchant marine of the Boston Chamber of Commerce in the report already referred to declared:

"Every important nation which has developed a merchant marine of its own has appreciated the need of creating at the same time a classification and insurance system of its own, instinctively recognizing the unwisdom of depending for such an indispensable service upon the resources of foreign competitors. It is earnestly believed by many American shipowners that the decline of our own mercantile marine was hastened by certain arbitrary discriminations of powerful marine insurance authorities of Europe, and it is the manifest course of prudence to make such discriminations impossible hereafter by providing requisite American standards of construction properly adapted to meet the particular needs of the widely varying types of ships required for American domestic and foreign commerce."

Since these recommendations were recorded, certain well-considered and vigorous steps have been taken by representative American steamship companies and shipbuilding corporations to provide a strong American classification and insuance system. The American Bureau of Shipping, founded in 1862 as the American Shipmasters' Association, has been thoroughly reorganized, with new management and new and powerful support. On its technical committee of advisers are some of the ablest men from American shipyards. The surveying force of the Bureau has been greatly increased; all of the surveyors are American citizens. The Bureau is in a position to add to their numbers as our shipbuilding programme grows. With the extension of the Bureau's service there has come a remarkable strengthening of American resources in marine insurance. Existing concerns have enlarged their field of operations. New concerns have been established. The business has proved to be a profitable one, and it is attracting American capital in such amounts that American shipowners have been more and more successful in securing complete underwriting in the United States. Conditions are such that if the government calls upon the American Bureau of Shipping for its entire survey and classification service the resources for undertaking all of it will be available.

A Thoroughly Unselfish Service

The Bureau holds a unique position for genuinely national patriotic service. It is not a money making organization. It has no capital stock, it pays no dividends. It exists solely for the purpose of providing at cost an indispensable element in the upbuilding of the great new merchant marine of the United States.

Its managers have no quarrel of their own with the old registry society of Great Britain. They recognize that the officers and employes of Lloyd's, as loyal British subjects, are under obligation to serve primarily the interests of the British mercantile marine and the British Empire. As the American Commissioner of Navigation declared in his report for 1890:

"The Society of Lloyd's and the members thereof are the volunteer protectors of the British marine. Leading shipbuilders, managing shipowners, millionaire merchants and rich underwriters compose the society and association. Many members of Parliament are chosen from the classes composing the Lloyd's, and there are always several members of Parliament on the committees which rule the proceedings. The Lloyd's have a policy in all they do. Nothing is undertaken that would be calculated to give foreign ships full equality with British. Leniency toward their own and severity toward foreign ships has ever been their motto. Their weapons are partiality and discrimination. Their rule is by associated action. Their power, derived from the amplitude of their transactions, knows no limit in the shape of commercial inducement."

That the spirit by which Lloyd's is dominated is still the

spirit of old was shown very clearly in negotiations which preceded the reorganization of the American Bureau of Shipping. It was thought for a time that there might be a certain international co-operation, but when the question was definitely put to Lloyd's representatives, whether in case a new design for an American vessel was made in this country, the American committee would have the power to grant a classification to such vessel without sending the plans to London, the answer came right back: "No; the plans must be sent to London for approval!" There and then the negotiations ended, and the American committee unanimously voted to make the American Bureau of Shipping absolutely American and independent of foreign restraint. So long as Lloyd's possessed the power to veto the plans of American vessels it would continue to have the power to choke the development of an American merchant marine in overseas trade.

Thus the American Bureau of Shipping, reorganized and reinforced, embodies a new American declaration of maritime independence. When the Bureau asks for the full sanction and support of the United States Shipping Board and protests, in this hour of great opportunity, against the employment of an alien and hostile classification society to control the construction of American vessels built and paid for with the money of our government, it has a right to expect the friendliest consideration from the authorities in Washington.

It is a good time in shipping, as in other vital national matters, to put none but Americans on guard.

Coal dust or any foreign matter can be removed from the eye by taking a few flax seeds and, after moistening them, placing them under the eyelid and closing the eye for a minute or two. The gelatinous coating of the seed picks up the foreign matter and carries it off.

Some quartermasters handle steering gear without any real sense of its use. One will turn the trick wheel so the engine makes a few revolutions to hold the course, while another will make the steering engine buzz like a flying machine motor. Get rid of this type of quartermaster.

Auxiliary Schooner Building in Texas

THE Tarver Shipbuilding Corporation, Beaumont, Texas, has under construction a three-masted auxiliary schooner, 172 feet long overall, 36 feet beam and 13 feet 6 inches depth, for the builders account. For auxiliary power the vessel is fitted with a 100-horsepower Fairbanks-Morse heavy duty crude oil engine, together with oil tanks for a fifteen days' supply of fuel. For operating the windlass and hoisting the sails a Chris. D. Schramm & Son hoist is fitted, operated by a gasoline (petrol) engine. The poop deck is 3 feet above the main deck with a 3½-foot passageway between the railing and deckhouse. The main cabin has three staterooms, the captain's office and bathroom. The crew's quarters are located on the forward deck.

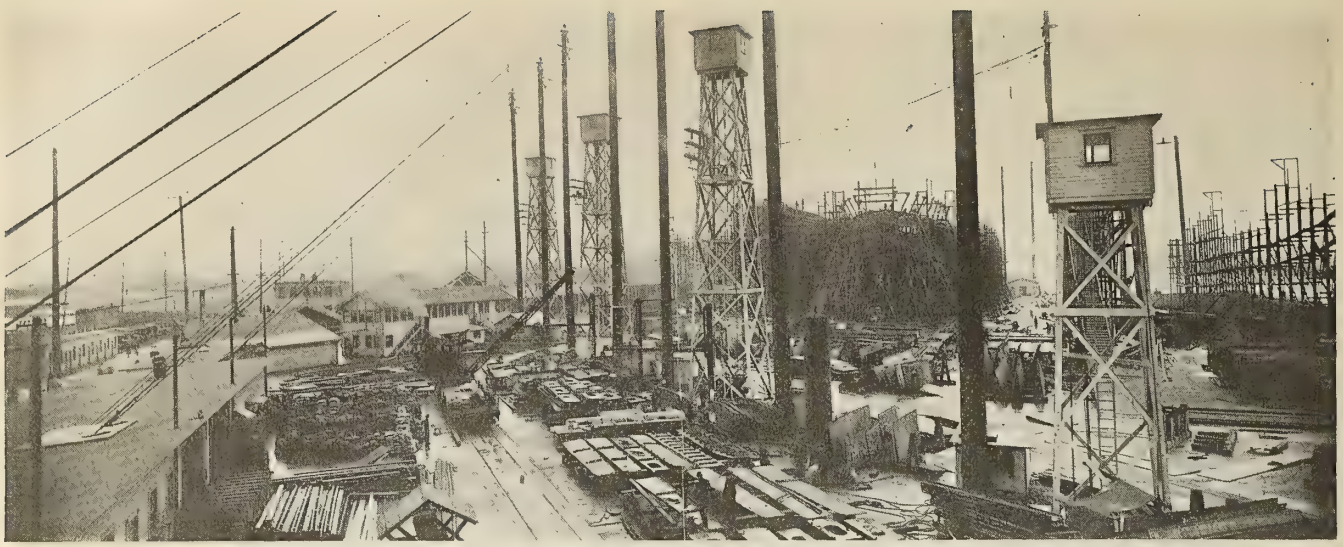
The hull is built of wood throughout, the keel consisting of 12-inch by 16-inch double long-length timbers. The stem is of live oak 12 inches by 18 inches rabbeted to receive the ends of the planking. The stern and rudder posts are 12 inches by 16 inches. The center keelson consists of three layers of 8-inch by 12-inch timbers and on each side are sister keelsons of 8-inch by 12-inch timbers, extending to the same height as the center keelson.

Three-masted Auxiliary Schooner, 172 Feet Long, Immediately After Launching at Yards of Tarver Shipbuilding Corporation, Beaumont, Tex.

The frames are 8 inches by 14 inches double, molded 14 inches on the keel and gradually tapering to 8 inches on the deck line. The first garboard strake is 6 inches by 14 inches and the second 5 inches by 12 inches. The planking from the garboard strakes to the band of the knuckle is 4 inches thick. From the waterline to the deck line the planking is 4 inches by 8 inches. The inside ceiling from the keelson to the bilge stringers is 6 inches by 12 inches and between the bilge clamps and lower shelf strake 7 inches by 8 inches.

The bilge stringers consist of six strakes of 8-inch by 12-inch timbers extending from the apron to the extreme length past the transom. The lower shelving is 10 inches by 14 inches worked to shape and the upper shelving 12 inches by 16 inches.

The deck beams are 10 inches by 14 inches; crowned, 6 inches in 36 feet and covered with 4-inch by 4-inch planking.



One of Seattle's Shipyards (Skinner & Eddy), Where Ships Are Launched in Record Time

Seattle Speeds Up Shipbuilding

Startles Staid Shipbuilders by Swift Construction of Shipyards and Ships—To Build a Million Tons This Year

IN the last calendar year the four steel shipyards of Seattle and the three yards building wooden ships during the year launched a total of 29 ocean vessels, having a total cargo capacity of 184,800 deadweight tons. Since November 1, 1917, the Seattle shipyards have launched twenty ocean-going merchant ships, sixteen steel steamships of from 7,500 to 12,000 tons deadweight capacity and four wooden ships of 2,600 tons or larger capacity, the total aggregate cargo capacity being 75,000 tons deadweight.

The shipyards of Seattle have building contracts on hand for more than $200,000,000 (£41,000,000) worth of first class ocean carriers, most of them steel ships of standard design and of 8,800 tons deadweight capacity. Eleven steel ships, complete in every detail and almost without exception exceeding contract requirements in their trial trips by from one to three miles per hour, and all without exception receiving Lloyd's classification as vessels of the 100 A1 class, have been delivered to the government since last November.

Seattle Shipyards Entirely New

While the most surprising characteristic in the development of Seattle shipbuilding, especially to the shipbuilders of the old world and the Atlantic Coast, is its unexampled and consistent efficiency, this is explained logically by the fact that all the yards are entirely new, have the most successful modern equipment and are conducted by men who have, before coming to Seattle, been thoroughly schooled in all the technique of the business.

Another unusual feature is the entire harmony of employer and employe, both in the shipbuilding plants themselves and in the auxiliary industries preparing material and machinery for the yards, involving in all approximately 27,000 men. They work together under conditions and wage scales agreed to mutually, and the men in the yards seem to be as enthusiastic in the matter of speeding up production as the owners of the plants themselves.

This admirable and unusual esprit de corps, together with the mild and highly favorable winter climate of the Seattle district, is credited in large measure with the fact that Seattle continues to be the pacemaker in the business of building the big steel carriers for Uncle Sam's new national merchant fleet.

Steel Shipyards

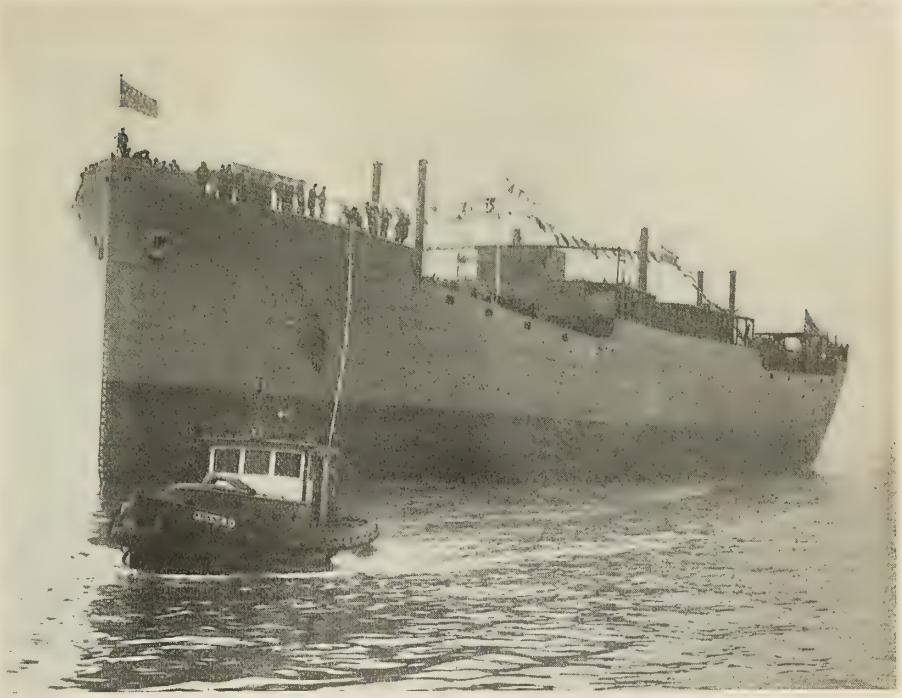
There are four operating steel ship construction plants on the Seattle waterfront, with two others about to be completed, both of which have obtained contracts for steel ships from the United States Shipping Board. The two uncompleted yards referred to are the Patterson-MacDonald Shipbuilding Company's 10-ways plant—five ways for steel and five for wooden ships—and the new plant of the Erickson Engineering Company, with five steel ship ways, and which recently closed contracts with the Shipping Board for the construction of ten 9,400-ton steel merchant ships.

One year ago there were but five ways in Seattle's shipbuilding industry for the construction of wooden ships. Now there are forty-seven ways in the wooden shipyards of the city. Wooden ship construction has this advantage in Seattle, and the Puget Sound district, that all its material has its origin in the immediate vicinity of the yard, for the finest ship timber in the world, as well as the best airplane timber, comes from the forests of western Washington and Oregon—Douglas fir and Sitka spruce.

S. S. Seattle Built in 78 Working Days

The outstanding achievement of Seattle shipyards is the accomplishment of the Skinner & Eddy Corporation's plant in producing the 8,800-ton steel steamship *Seattle* complete in 78 working days. The *Seattle* was built under the 84th contract awarded by the United States Shipping Board, and she was the first direct contract vessel of the emergency fleet launched in the United States, being launched November 24, 1917. Less than a month later,

December 22, the same yard launched another 8,800-ton steel ship for the Shipping Board, the *Absaroka,* thus finishing its first year in which its plant had sent 100,400 tons deadweight of new cargo carriers down its ways. The latest launching by this yard was on February 27, when the 8,800-ton steel steamship *Canoga* was sent down the ways for the Emergency Fleet, and at the same time the steel steamship *West Arrow,* 8,800 tons, completed her trial trip, exceeding requirements, and was delivered to the government, all within three hours, being the eleventh complete steel ship delivered to the government by this one plant.



S. S. *Seattle,* the First Direct Contract Ship Finished for Uncle Sam. Launched at Seattle on November 24

How the Record Was Made

The complete equipment of the Skinner & Eddy plant may be largely responsible for the wonderful building performances of this yard, but among Coast shipbuilders, the superior skill and executive ability of General Manager David Rodgers, and the economic and efficient system of operation which he has established and maintained are chiefly credited with the great record. Moreover, the Skinner & Eddy Corporation, like most of the Seattle yards, has always met the just demands of its employes, or in most instances anticipated them, so that it has never experienced the least spirit of dissatisfaction or unrest among its skilled or unskilled men. Indeed, the men exemplify loyalty and enthusiasm in their work at all times. Mr. Rodgers has perfected what might be termed a fabrication of all parts of a ship. That is, he consistently maintains a method of supplying finished material for any part of a ship under construction, piled up ready for use, exactly at the point of installation, and this method has been perfected at this plant to such fine detail, that the first plate, shape, bar or bolt required is always on top.

Perhaps the least understood problem of Seattle shipbuilders, so far as their Eastern brethren are concerned, is the question of supplying steel from such great distances, for all of it comes from more than half-way across the continent. It was amazing, and indeed inconceivable to Eastern shipyard men, when the Seattle steel shipyards, so remote from the source of steel production, picked up the American shipbuilding speed and efficiency banner and retained it consistently ever since the beginning of the Emergency Fleet Corporation's building program. The Seattle yard managers explain this by stating that in nearly every case they have anticipated construction many months in advance, and have ordered their steel supply accordingly.

Builders of the Battleship Nebraska

The splendid plant of the Seattle Construction & Dry Dock Company, which is the pioneer steel shipyard of the Pacific Northwest, and which in 1905 launched and completed the only battleship ever built on the Pacific Coast north of San Francisco, the battleship *Nebraska,* which later made the famous 15,000-mile trip around South America to join Admiral Schley's squadron in Cuban waters, rivals the Skinner & Eddy plant in size and production capacity, each of these yards employing more than 5,000 men. On December 19, 1917, the Seattle Construction & Dry Dock Company launched the 12,000-ton steel steamship *Walter A. Luckenbach,* commandeered by the Shipping Board, the largest steel vessel ever built in the Pacific Northwest.

The two other steel plants now building vessels for the government in Seattle are those of the Ames Shipbuilding & Dry Dock Company, equipped to build and install everything required in steel ship construction, including engines, boilers and steering gear,

Auxiliary Powered Schooner *Ypres,* Launched at Seattle, January 18, Proceeded on Her Maiden Voyage and Trial Trip Immediately After Launching

and J. F. Duthie & Company, also a completely equipped yard, both of which have remarkable records of speed and first-class construction. The Ames plant, whose site was idle mud flats less than a year before, launched its first steel ship of 8,800 tons cargo capacity November 24, 1917. This was the steamship *War Brigade,* commandeered on the ways, when under construction for the Cunard Steamship Company, by the United States Shipping Board, and renamed *Westerly,* now in active service for the government. President Edgar Ames, of this company, by the way, is recognized as the creator of Seattle's present waterfront industrial district, having spent eighteen years of his life in the work of financing and directing the reclamation of 25,000 acres of idle tide land, comprising all that shore front district south of King street and the wholesale center.

Duthie Yard

The J. F. Duthie & Company yard, antedating the Ames plant by but a few months, completed three 8,800-ton steel steamships in 1917, two under contract for the Cunard line and one for Peter Kleppe of Norway, all commandeered by the government and renamed *West Point, Westfield* and *Westward.* All of these vessels exceeded their speed requirements and received Lloyd's classification of 100 A1. This yard is now averaging one launching per month.

With this successful start the Duthie yard gives every promise of setting new records in Seattle shipbuilding.

Seattle Yards to Deliver 1,000,000 Tons Deadweight in 1918

The shipyards of Seattle, so far in the new year, have averaged one 8,800-ton steel steamship complete, every eight days, and have undertaken to build and deliver complete to the government Emergency Fleet Corporation, an aggregate of one million tons deadweight cargo capacity of new steel and wooden carriers of the first class within the present calendar year. This is obviously a big order for these new yards, but the output of one wooden and eight steel steamships in the first two months of the year, with only four of the six steel shipbuilding plants in full operation, has convinced critical observers that target is easily within range, and that before the opening of summer the Seattle yards will be turning out, complete, about 10,000 tons of new cargo capacity per week.

Seattle's Forging Plant

A most important addition to the shipbuilding facilities of Seattle is a complete steel forging plant now in operation, the only plant of the kind west of the Mississippi river, which is now supplying steel stern frames and stems to the big shipyards of the North Pacific Coast and has furthermore already undertaken large construction work for Oregon, California and even East Indian shipyards. This forging plant, therefore, has brought a practical solution of one important phase of the steel problem with which the Coast builders have had some difficulty and delays.

Seattle's New War Industries

Shipbuilding and Airplane Manufacture of First Importance—Full Capacity Not Utilized by the Government

BY CHARLES PHILIP NORTON

WHILE Seattle's records for rapid building and delivery of ships stand alone, Seattle is much disappointed, because the Government is not making greater use of its peculiar advantages for producing war supplies. Instead of building one million tons of new ships, the Seattle yards claim to be able, with Government cooperation in providing steel and labor, to produce this year three million tons. Instead of building fifty airplanes, as at present, Seattle has materials and labor for the production of 5,000 machines this year. Instead of having 28,000 men employed in war industries, Seattle would keep 100,000 busy for winning the war.

Vanguard of 10,000 Skilled Workmen Mobilized for Building Ships at Seattle by the Government

Young Women of Seattle Are Taking the Places of Helpers and Young Mechanics Who Have Gone to War

With plenty of coal and assured deliveries every month in the year; plenty of the cheapest hydro-electric power; the most efficient labor, and a climate which permits men to work outdoors the year round, Seattle claims matchless industrial advantages. As for the climate, there has been no time lost on account of cold, storms, or extremes of any kind. The residents were mowing their lawns and clipping roses outdoors in January, when the Eastern people were shivering in zero temperatures.

Most of the spruce for airplane manufacture is being supplied by Puget Sound, but somehow the Eastern manufacturers have neglected Seattle as an ideal place for the location of branches and the raw materials are sent East. During the month of January, 260,000 tons of raw materials arrived at Seattle from the Orient, and capacity cargoes were returned.

Washington, D. C., recently was flooded with appeals to co-ordinate its work by having emergency contracts filled at Seattle, rather than permit disaster because of industrial paralysis east of the Rockies. Urgent appeals also were sent broadcast for manufacturers to establish branch factories in Seattle. The argument was that this not only would assure victory in the war, but would enrich the manufacturers after peace is restored.

The Seattle business men disclaim greed for war profits. They are concerned most in national triumph, saying: "Our money will be worthless, if we lose the war." They also point to what they call a certainty, that the trade with Siberia, the Orient, and Alaska, after the war, will be great enough alone to make Seattle a world metropolis, and that the city, therefore, does not need to advertise its resources to gain any advantage in business or population.

The Government is co-operating to the extent of employing 10,000 additional skilled shipyard workers for Seattle, who are to be "on the jobs" within the next ninety days. The first contingent arrived January 20. The men were received with public honors. Homes had been provided for them. Accommodations for future arrivals are now being prepared. Seattle has solved its first housing problem.

All serious labor trouble has disappeared in the Pacific Northwest. The I. W. W. agitators are now at work and organized labor is co-operating efficiently with the Government.

Seattle's records have been made possible, in part, through the efforts of thousands of patriotic women, young boys, girls and wealthy men beyond military age. They participate in certain lines of work by taking places vacated by young mechanics and helpers who have gone to war. Through them every available man, having any knowledge of machinery, is released for service in the great shipyards. In this way, Seattle is one hundred percent efficient in war work for all, and is doing its part towards conserving the trade facilities between this nation and the world.

Girls, Elderly Men and Boys Aid in Work

The rapid manufacture of radio outfits for 250 government vessels and many private merchantmen is regarded as of vital importance. The president of the largest plant recently tried the experiment of giving young women a chance to show what they could do as helpers to mechanics. Many of them soon showed such mechanical ingenuity and natural skill that they promptly were promoted, without regard of sex, to the operation of turret lathes, each of which does the work of seven ordinary engine lathes; punch presses, power drills, etc. This plant now employs about 100 girls and a great many more are to be put to work.

The young women, of course, cannot do the work of expert machinists, who devote years to experience and special training, for much of their work requires finishing of the utmost mechanical finesse, down to the ten thousandth part of an inch.

"Before America entered the war we were able to get plenty of young men from the colleges and schools," said the president of the company, "but so many of the boys have gone to the front that we were forced to the conclusion that the girl-in-overalls offered the only solution of our labor problem. They are doing wonderfully well indeed—doing their bit for the national cause."

While the women are filling in on jobs for which they are adapted, thousands of mechanics of the building trades are learning the A-B-C of shipyard work. More than 500 carpenters, for example, enrolled within a week for an instruction course, under patronage of the Federal Government. The school was established by the

Hundreds of Carpenters and Other Skilled Mechanics Attending a Shipbuilding School in Seatile

carpenters' union, with the co-operation of the school board and the federal experts. Interest is so great in the shipbuilding course that hundreds of others will enroll as facilities for instruction are added. The United States Shipping Board assigned, as instructor, Captain W. W. Varney, a veteran shipbuilder. He recently established at Tacoma what he says is the first really practical school for shipbuilding in America, where he is now training 250 mechanics. The Seattle school is the second of its kind in the country, Tacoma's being the first.

Carpenters Resume Their Schooldays

Captain Varney starts classwork with the rudiments of shipbuilding. With the aid of a blackboard, he builds a ship from the keel up, before the eyes of the eager class. The students are all mechanics, most of them skilled in house carpentry, whose last previous experience of school was fifteen to fifty years ago. They know all about tools and how to use and care for them, but most of them are unfamiliar with even the names of the various parts of a ship.

Late in 1917, the official announcement was made that two more large steel shipyards were to be established immediately, to build vessels for the Emergency Fleet Corporation, and that these yards, together with the development of existing plants and of auxiliary manufacturing establishments, would require the employment soon of twenty thousand additional skilled mechanics. The government proposed to employ the workers wherever they could be found, without conflicting seriously with the interests of their present employers and to bring them to Seattle as fast as needed. They were recruited from non-essential industries. Federal officials met with the war shipping committee of the Chamber of Commerce and Commercial Club and advised that the problem of housing the newcomers be solved at once.

Roused by this challenge to the Seattle spirit, the Chamber immediately began work on a house census, in which the postoffice employees and mail-carriers assisted, and devised plans of utilizing all vacant buildings suitable for dormitories for bachelors. After developing for use all existing facilities for housing the mechanics, whose families also arrived in large numbers, the work of building new cottage homes began. The "own your home" campaign is now under way. This will be, perhaps, the greatest house-building programme in the history of western cities, and it must be completed within ninety days. Patriotic architects are offering free services. The committee workers declare it shall be done and all creative forces at the disposal of the Chamber are being coordinated for the work.

Absolute harmony of effort is maintained, including the services of union leaders. The general aim is to absorb the thousands of newcomers into the city's permanent industrial population. If this is done, as the committee workers declare it will be, Seattle will have a mighty population of highly trained mechanics. If the war should end in the spring, 'tis said, the Seattle shipyards have enough contracts now to assure a continuance of double-shift activity in all of the shipyards for at least one year.

The city-builders are advised, however, that the end of the war will mark the beginning of an even greater shipbuilding programme. America's merchant fleet, to be given preference, will require a complete overhauling. Every vessel afloat to-day will be in need of drydock repairs. Hundreds of new ships will be needed to round out the Nation's cargo-carrying fleet—one for the Pacific and one for the Atlantic, and one especially constructed for the coastwise trade. Besides the needs of America, every country in Europe will want ships and the demand will continue unabated for many years.

A "cuss word strainer" on the voice tubes to the engine room would be a salable article. It might sell also to the telephone companies. Some genius should get after the idea.

Magnesite Composition Decking

What It Is—How It Is Manufactured and How It Should Be Applied—Specifications

BY G. W. SELBY*

"WHAT decking material to use" is a question occupying a prominent place in the minds of those responsible to humanity for delivering the largest number of ships in the shortest space of time ever allotted for such a gigantic task. The principal factors entering into the decision may be stated in the order of their relative importance as follows: Merit of material, availability, time for installation, and cost of installation and maintenance.

The material which is to be considered, above all others, as meeting the foregoing requirements is magnesite composition decking. A most important point in its favor at this time is the fact that it increases the man-power of the shipyard by releasing for other work all mechanics usually employed in lining out and fitting a wood deck. Furthermore, the work of laying magnesite composition decking is let out to a contractor at a definite price per square foot, thus relieving the purchasing, accounting, stores, and traffic departments of a large burden which would ordinarily be theirs if lumber were to be bought, expedited over congested rails and stored for a considerable time. Lumber is difficult to obtain and is therefore constantly rising in price.

Materials

The materials of which magnesite composition decking is composed are available in large and increasing quantities in this country. They consist of calcined and ground magnesite mixed dry with certain fillers calculated to give the finished product hardness commensurate with elasticity; and this mixture is added to magnesium chloride solution in a mortar box and applied to the deck with a trowel, the deck having previously been covered with suitable contrivances to "key" the composition to it. The composition, when troweled, presents a smooth and level surface, unbroken by seams, pleasing to the eye and of remarkable strength and durability.

It is considered the best practice, as an insurance measure, to coat the deck first with a suitable bituminous solution in a heavy coat, although the writer has seen several deck plates bared of composition decking during repairs that showed no corrosion whatever.

Speed of Application

Composition sets up in about ten hours during the hot summer months, and in about 48 hours during mid-winter. It cannot freeze, hence there is no interruption of operations. One mechanic with helpers can apply from 250 to 500 square feet per working day, so it will be recognized that the most rapid construction will not be delayed because of its use. Rather will deliveries be hastened, because the trowelers may start as soon as the deck plates are complete in place, and this fact serves to increase the incentive to spur the riveting work. The joiners start to work immediately the decking is set up, and they fasten their sills to the material with ordinary wood screws, so that they keep behind the trowelers, spurring the latter in turn, to greater effort. It was figured that on an 8,000-ton passenger steamer, built on the Atlantic Coast a few years ago, magnesite composition decking delivered the ship from four to six weeks ahead of schedule. Think what this means to-day!

Best Magnesite Produced in California

The principal source of magnesite for use in floor or deck composition was in Eubea in Greece, prior to the present war, but during the past three years practically all the magnesite used for this purpose has come from California. It is mined, sorted, and burned, to free it of practically all of its carbonic acid, then ground and packed. The California product has always been known to be superior to any other in the world, but, because of the low cost of production, the Grecian material could be laid down in this country at a price far less than the cost of production of the California material, plus the relatively high freight rate. The California firms are now producing to capacity and a tremendous amount of money has been spent in the development of new mines and the purchase of machinery for calcining and grinding. The production of magnesite in this country, not only for flooring compositions, but for refractory and fluxing purposes as well, has proven to be a very important "war baby."

Practically all magnesium chloride, which is used in the wet mixture of magnesite composition, came from Germany until about four years ago. It was obtained as a by-product from the production of potash from carnallite, a native salt found in the salt beds at Stassfurt. After the potassium chloride had been extracted by crystallization, the residue was packed and shipped as magnesium chloride, and as a consequence it carried a number of impurities. Now there are firms in the United States producing better and purer magnesium chloride than ever came from Germany and furnishing it to the composition trade as well as other industries in the United States.

The resourcefulness of our manufacturers is to be commended for making possible the continuation of a business which is destined to play quite an important part in our shipping program.

Laying of Magnesite Composition Decking

Magnesite composition decking may be used merely as a sheathing, a suitable rubber tiling being glued to it, or it can be laid as a combination sheathing and surfacer. Mineral colors incorporated in the mixture give a very pleasing effect to the finished floor. Laid in one unbroken layer, it requires no calking or repairs and presents no harbor for vermin. Inasmuch as its principal ingredients are refractory, the finished floor is both fire proof and non-inflammable. It may be truthfully stated that no material of a hydraulic nature is watertight, strictly speaking, because of the voids caused by the evaporation of water. Magnesite composition, however, in tests has absorbed less than 2 percent of its own weight of water after being submerged for four weeks. This test was performed with a sample, only ½ inch thick, so it will be seen that the penetration is not very deep.

* Secretary Marine Decking and Supply Company, Philadelphia, Pa.

It can safely be considered as watertight. It is comparatively noiseless to the tread and is quite efficient as a thermal insulator, so that it is warm to the touch.

Composition flooring, as it is called in the building trades, had been in use on land for a number of years before it was thought of for ship decking. It is a widely discussed material among architects and most of them will agree that, properly applied, it is an ideal floor where beauty and utility are to be combined. The same statement holds true for marine work.

Type of Composition Decking Must Be Carefully Chosen

Dr. John Hamilton Patterson, in the September, 1914, issue of *The Shipbuilder,* lays particular stress on composition decking of the magnesite type. He discusses very fully all types of decking in his article, "Deck Sheathing Compositions," and referring to magnesite composition decking, he states: "There can be no doubt that some compositions as laid down are unsatisfactory or even dangerous, but given rigid adherence to certain conditions they are as safe as, or safer than, wood or other deck." Dr. Patterson's article was an exposé of some of the causes leading to the occasional failure of decks of this type abroad, where they have been in use for years.

Practically every large liner built in Europe has, since about 1904, been covered with magnesite composition decking, and since the demand was so great, there sprang into existence any number of contractors who took contracts at low prices, sophisticated their material, and "skinned" their jobs, with the result that the sheathing disintegrated, and often the deck corroded. Shipping interests began to look askance at any sort of composition decking. The quotation from Dr. Patterson's article speaks for itself, and, inasmuch as America will be the world's largest buyer of material for building ships, it is imperative that Dr. Patterson's words be heeded so that Europe's mistakes in choosing the kind of magnesite composition decking are not repeated.

Therefore, in choosing, the shipbuilder or owner must consider the reputation and experience of the firms bidding for the business, and the efficiency of the organizations bidding for the work should also be closely scrutinized. There is so much of care in the purchase, the manufacture and the testing of the raw materials, so much of experience necessary in their proper application, that it behooves those responsible to choose wisely before naming the kind of material to be used, because thousands of dollars may be lost, not only by the failure of the sheathing, but the corrosion of the plates beneath as well.

Beware of Irresponsible Contractors

There have been many firms who have started up as magnesite composition contractors with only enough capital to buy a few tons of raw materials and pay their mechanics for a few weeks. The principals in these firms have usually been men who have worked at laying these floors, and they seldom are equipped with the necessary knowledge of the chemistry of the material they apply. The use of rule of thumb methods, in a business which is extremely technical, and the fact that such a limited amount of capital is required to commence operations, have persuaded them to embark in business with subsequent disaster, not only to themselves, but to the trade at large. When a particular brand of magnesite composition fails in service, the critic does not particularize, but condemns "composition" generally, which is manifestly unfair to those firms with considerable invested capital, an organization of experts, and a reputation for good work.

A frequent cause for the failure of magnesite composition in service is a reduction in the percentage of magnesite used, or a decrease in the strength of the magnesium chloride. These two ingredients are the highest in price of all the materials entering into magnesite composition decking, and are therefore most likely to be reduced by unscrupulous contractors.

Therefore, it is urged that the shipowner and shipbuilder should make diligent inquiries as to the respective standing of all bidders, their experience in applying magnesite composition on ships in particular, as well as specifying a definite course of procedure as follows:

Specification

(1) Specify the application of a heavy coat of bituminous material which will adhere permanently to the steel deck and which will not become brittle.

(2) Maximum and minimum thicknesses (the latter over butt laps) to be specified and enforced to prevent unscrupulous contractors from "skinning" the job.

(3) Specify that a satisfactory method be employed of bonding the material to the steel deck. "Roughing up" the deck is not satisfactory.

(4) Specify that the material must be such that it may readily be tapped with woodworker's tools and yet not so porous as to retain more than a slight amount of moisture.

(5) State that consideration will be given only to those firms which have laid material satisfactorily on ships, satisfactory proof of this to be furnished.

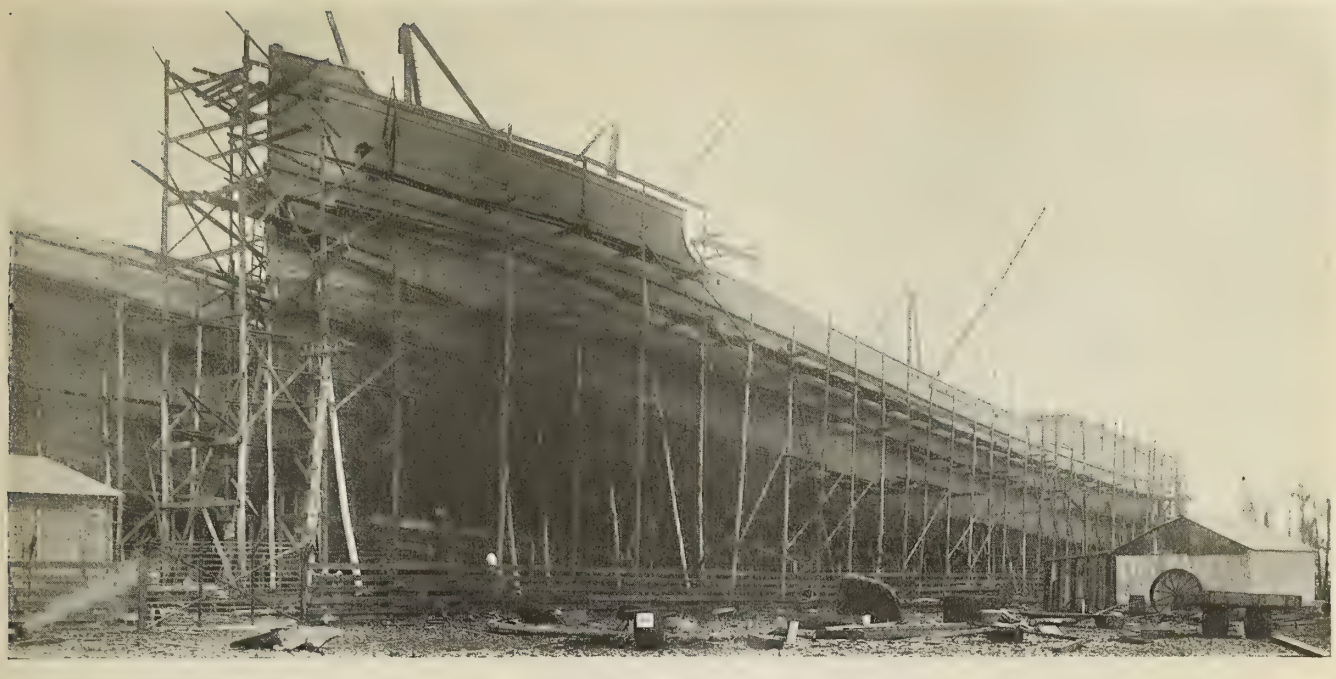
Unless the foregoing general rules are strictly adhered to, there will be some dissatisfaction expressed in this country, as well as in Europe, in the future, regarding magnesite composition as a ship decking. Those firms in the business who are in a position to comply with the specifications given will welcome investigation, because they are in the business to stay, and will, with the help of the shipping interests, do at least their bit in hastening deliveries. These firms know the merits of their products, are sure of their ground, and are confident that the ultimate judgment of the shipping world will verify the fact that magnesite composition stands pre-eminent as a decking for ships the world over.

Largest Wooden Vessel Launched

THE *War Mystery,* the largest wooden steamship ever built, and of an entirely new type of construction, was successfully launched at an American port on February 27. If the confident prediction of the designers and builders is realized, this vessel will end the controversy as to the practicability of the wooden ship and the problems that have hampered its rapid production.

The *War Mystery* is the first of twin vessels contracted for by the Cunard Steamship Company and built by the National Shipbuilding Company of Texas. The second vessel, which is practically complete, and which was christened the *War Marvel,* was sent into the water two weeks after her sister ship. Lying on the ways in the National Company's yards are six other ships of the same type that are being rushed to completion under a Government contract which calls for a total of twelve ships from this company. The first of the Government ships will be launched about April 1, and the others will follow at intervals of a few days.

In design and construction, the *War Mystery* and her sister ships differ radically from the Ferris type of wooden ship adopted by the Emergency Fleet Corporation. One of the principal differences is that the *War Mystery* has



The *War Mystery* Under Construction in Texas by the National Shipbuilding Company

a deadweight carrying capacity of 4,700 tons, as compared to 3,500 tons of the Ferris model, yet the larger vessel requires less than 1,500,000 feet of material to construct, as compared to approximately 1,750,000 feet required for the Ferris ship. Another feature that is said greatly to facilitate rapid production of ships of the National Company's design is that they require no timbers of extraordinarily large size, so that the Southern lumber mills are able to supply easily and quickly any quantity of material desired. Southern lumbermen have insisted that if there has been any delay on their part in supplying material for the Ferris type ships, it has been due solely to the requirements for timbers so large and long that it was next to impossible to find them in the Southern pine forests.

The *War Mystery,* which is identical except in a few minor details with all the wooden vessels being constructed by the National Shipbuilding Company of Texas, has a length over all of 315 feet, and a length between perpendiculars of 300 feet; a molded depth of 28 feet 6 inches; molded beam, 48 feet; beam outside planking, 49 feet 7 inches; draft, 24 feet. She is built throughout of dense Southern yellow pine, with the exception of stem and stern posts and engine foundations, which are of oak. Among the unique features embodied in her construction are:

Frames of "built-up" timbers, scarfed and tied together with hardwood treenails, machine driven. Directly upon the outside of the frames and continuing uninterruptedly beneath the hull on top of the keel is nailed a double layer of diagonal strapping of material 1¼ inches thick and 9 inches wide. These diagonal courses are laid at right angles to each other and are designed to aid in giving the vessel extraordinary rigidity and strength, offering resistance to tension, compression and strain from every

View on the Deck of the *War Mystery,* the Largest Wooden Steamship Under Construction

angle. The outer planking proper varies in thickness from the garboards, where it is 8 inches, to 5¼ inches on the vessel's bottom, and 4¾ inches on the sides. The sheer strake is 7 inches in thickness. Inside the vessel is ceiled throughout with 7-inch planking.

The vessel has a comparatively light keel—9 inches. The bottom of the ship has a floor of solid timbers, laid three deep and totaling 36 inches in thickness. The keelson is a steel plate 5 feet wide, running the entire length of the vessel, and on which is mounted a fore-and-aft wood girder 18 inches deep. The bottom of the ship is further reinforced with additional keelsons of wood, 15 inches square, one at the turn of the bilge and the other midway between the bilge timber and the metal keelson. The heavy timbers in the vessel are fastened with screw bolts, instead of the clinch bolts frequently used.

The largest single sticks required in the construction of this vessel are the deck beams, extending from side to side. These are 15 by 15 inches, 48 feet in length.

Propelling Machinery

The vessel will be driven by 1,450-horsepower, triple-expansion, reciprocating engines, with Babcock & Wilcox watertube boilers. Another variation from the Ferris type ship will be the location of the machinery, which in the *War Mystery* will be well toward the stern of the ship, rather than amidships. This arrangement leaves the cargo hold "all together," and this, with three unusually large hatches, will make loading and discharging cargoes exceptionally easy.

The vessel is not intended to carry sail, and the masts will be derrick posts 45 feet in height, built to fold down upon the deck, so as to lessen the visibility of the ship and reduce the danger of being accurately located at a distance by enemy vessels.

The *War Mystery* and the sister vessels of her type have been given an A1 rating by Lloyd's.

The officers of the National Company say they can produce ships of the *War Mystery* type within thirty days after construction begins, and, since the company has ways for eight vessels, the future production will be at the rate of thirty-two ships annually.

Rapid Growth of the National Yard

The work already accomplished at the National yards is a remarkable example of "speeding up" to meet urgent war needs. On May 1, last year, the site of the shipyards was the boggy, reed-grown shore of a river. To-day it is fully equipped with everything needful in the way of machinery for modern shipbuilding, is already well on its way to the production of eight ships complete, and has a trained working organization of more than nine hundred men, exclusive of master mechanics and directing supervisors.

The owners and directors of the National Shipbuilding Company of Texas are for the most part men largely interested in oil, and when the installation of a shipyard at this port was first undertaken the purpose was to build steel oil tankers, an intention that was abandoned, temporarily at least, when this country entered the war with Germany. The principals in the organization are: A. A. Daugherty, structural contractor and engineer, formerly of California; P. J. Reilly, of Philadelphia, president of the National Oil Company; John F. Penrose, of Philadelphia, owner of oil properties in Mexico; G. Van Alstine, of California, secretary of the company, and W. A. Ebsen, of New York, ship designer and engineer. Concerning the vessels being built at the National yards, Mr. Ebsen, the company engineer, said:

"These ships, as we are equipping them, are not intended for speed, though they are designed along clean and graceful lines. They are, however, built for hard, practical use in the North Atlantic or any other sea, and we have not the slightest fear of their failing in any particular. We are giving each vessel built the most careful study, and are constantly adding minor improvements that tend to increase the stability and serviceability of our ships. I can scarcely believe that any practical designer or builder who inspects the *War Mystery*, our first production, lying there in the harbor can doubt that she is a staunch, practical and thoroughly seaworthy ship."

Thousands of residents of this port city and scores of shipbuilders, lumber manufacturers and others directly interested in wartime shipbuilding cheered while the *War Mystery* glided into the water on the day of her launching. The launching was an entire success, in spite of natural difficulties presented by a very limited expanse of deep water adjacent to the shipyards.

Cargo Steamship Santa Tecla Launched by New York Shipbuilding Corporation

ORIGINALLY started as a stock hull by the New York Shipbuilding Corporation, Camden, N. J., the S. S. *Santa Tecla*, a cargo vessel of 3,800 tons deadweight carrying capacity, which was launched 85 percent complete on February 28, has been taken over by the United States Shipping Board Emergency Fleet Corporation. The keel was laid in September, 1917, and, considering the weather conditions of the past winter, the construction of the vessel has progressed very rapidly.

The vessel is a single screw steel freighter with machinery amidships. The length overall is 310 feet 5¾ inches; length between perpendiculars, 299 feet 10½ inches; beam, molded, 40 feet and depth molded 26 feet. On a draft of 21 feet, the vessel is designed to carry a total deadweight of 3,800 tons, and, in this trim, to make about 10 knots sea speed under ordinary conditions.

There are two decks with poop, bridge and forecastle and an inner bottom which runs throughout the length of the vessel. The inner bottom is divided into sixteen compartments for carrying fuel oil and water ballast. Steel deck houses are erected on the bridge deck with a wood pilot house and captain's quarters, on top of the bridge deckhouse. The officers and engineers are berthed on the bridge deck and the crew aft.

The cargo space is divided into three holds with four hatches, 24 feet by 14 feet, fitted with shifting beams 4 feet apart. The hatch covers are of wood in small portable sections. The total capacity of the cargo holds is 165,000 cubic feet. The forward end of the midship house is also available for cargo, worked through large door openings on each side of the forward bulkhead.

The fuel oil is carried in bunkers located abreast the boiler room and in the double bottom. The peaks are also riveted and stiffened for carrying oil but are not piped for this purpose. The capacity of the fuel oil bunkers, exclusive of the peaks, is 600 tons at 40 cubic feet per ton.

Drinking water tanks of 7,000 gallons' total capacity are provided and reserve feed tanks are under the machinery in the double bottom.

The vessel is schooner-rigged with two steel masts heeled on the main deck. Four steel booms are fitted to each mast, each capable of handling a 3-ton working load. Between the forecastle and bridge and poop, bulwarks have been dispensed with, and a double chain rail fitted instead.

Propulsion is by a vertical inverted direct-acting triple expansion surface condensing engine, arranged to work on three cranks, and to drive a right hand screw propeller. The cylinders are 19¾ inches, 31½ inches and 54¼ inches diameter, with a common stroke of 36 inches. Steam is supplied at 200 pounds working pressure by two single ended Scotch boilers, 13 feet mean diameter and 11 feet long between heads.

The engine bedplate is of cast iron, of strong box sections with six iron girders of box section, suitably recessed for the main bearing boxes, bolts and nuts. The main bearings are six in number, of the square bottom type to facilitate re-lining. The upper caps and boxes are of cast steel in one piece; the lower boxes of cast iron.

The cylinders are supported on three front and three back housings of cast iron box section, provided with suitable flanges for attachment of the cylinders and to the bedplate. The high pressure and intermediate pressure cylinders, each have one piston valve and the low pressure cylinder, one double ported slide valve—all worked by Stephenson link motion.

The main condenser, containing 2,100 square feet of cooling surface, is independent of the main engine. The pumps for fire, ballast, etc., are all independent and located in the engine room. The auxiliaries also include an electric plant consisting of two vertical marine generating sets of 7½-kilowatt capacity. A main switchboard and distribution panels are provided for controlling the lights in the living quarters, etc. Approximately one hundred 110-volt 25-watt Mazda lamps are fitted throughout the vessel.

Great Lakes Shipping

ACCORDING to William Livingstone, president of the Lake Carrier's Association, the 1918 season on the Great Lakes will open propitiously. In his annual address to the association he said:

"The association will begin 1918 with an increase in membership so far as the number of vessels is concerned. No material losses through shipwreck were sustained in the past seasson, with the exception of the small freighter *Goudreau,* and the sales of vessels in memberships to the Atlantic coastwise service were small in comparison with the preceding twelve months. The requirements of the Government have so far been largely confined to the package freighters, and have removed only seven vessels of 15,893 gross tonnage from our membership.

"Our extensive building programme commenced before the war seemed a possibility, reached completion with the launching of the steamer *August Ziesing,* on October 30, and this new construction, together with some recovered property, has added to our membership twelve bulk freighters of 89,301 gross tonnage, of which seven are 600 feet and four 545 feet overall in length.

"Until the war will have come to an end there can be no hope for any further increases in our association's tonnage through new construction. Nevertheless, the present membership represents a total of 2,084,922 tons, an amount adequate for successfully handling almost any burden that the nation may impose upon us."

Reviewing the season of 1917, which, through weather conditions, was very unfavorable, Mr. Livingstone said:

"All available ships were ready early for opening navigation on April 15, and the outlook appeared optimistic, inasmuch as Lake Erie, from Detroit River to Conneaut, was clear of ice on March 20, while the Cleveland harbor opened on March 16, an advance of three weeks over the preceding year. On April 1 the river and channels up to Lake Huron were open and the steamers *Maruba* and *Emory L. Ford,* that had been caught at Port Huron at the close of navigation in 1916, proceeded down with their cargoes of grain. On April 12 the steamers *Wm. P. Snyder, Jr., Col. J. M. Schoonmaker* and *Shenango* made a dash from Buffalo harbor with the hope of getting through, as they did one year previously, but they were caught in the ice three miles up the lake and held until April 19.

"In the upper lakes and rivers the ice conditions were the worst of a decade. On March 30 there were 26½ inches of ice at the Sault, and 38 inches in Duluth harbor. There was found at the head of Lake Superior the unusual condition of 28 inches of hard, blue ice and heavy ice extended out from Two Harbors for twelve miles.

Sault Locks Opened Late

"Not a downward cargo passed through the locks at the Sault in April, but Lake Michigan and the Straits having kept free, it was possible to trade with Escanaba, with the result that twenty-four cargoes of ore got away in April, but only ten were delivered in the month, equally divided between South Chicago and Lake Erie ports. The steamer *Martin Mullen* reached Cleveland on April 27 with the first ore cargo, and on May 1 the *Hydrus* reached Buffalo ore-laden.

"It is notable that the first round trip from Buffalo to the head of the lakes, as made by the *T. H. Wickwire,* was not completed until May 8, while the first round trip to Duluth, as made by the *Harvester,* was not completed until May 10. Throughout May this tedious, expensive condition continued.

"In July the fleet brought down 10,241,633 tons of ore, the largest in history, and this was accomplished after the most serious unloading delays in the first ten days of the month that a modern fleet ever encountered.

Grain Trade Spectacular

"The grain trade of last spring and summer was spectacular in all its aspects and contributed one of the most interesting chapters to the eventual year's business. Although the stocks in the Northwest were considerably reduced in comparison with other years, a demand for tonnage made itself evident early in the new year.

"During the flush of grain's activity 149 steel bulk freighters participated in the movement. The late opening of navigation and the interference of ice set the fleet back about three weeks, it was conservatively estimated, and yet up to June 1 the Buffalo elevators unloaded 44,190,336 bushels and the loss stood at only 1,410,416 bushels from the exceptional rate of the year previous."

Remember, oil is lazy and very unobliging; it will never accommodate you by working to the center of a bearing, but will always work from the center out.

Many engineers forget, or never knew, that in a non-reversing engine only one side of the crank pin gets any wear. Think this statement over and you will find it true.

If the fillets of a crank pin are touched by the ends of the brasses when cold, when they warm up they will expand onto the fillets, lifting or tending to lift the brasses from the pin, thus resulting in cutting or heating, and you have trouble. See that there is a good clearance between fillets and brasses. A little too much is better than not quite enough.

Fig. 1.—Reinforced Concrete Pier Shed at Thirty-Fifth Street Pier, New York

Concrete in Marine Terminals

Retaining Walls, Breakwaters, Piers and Pier Sheds Being Built of Concrete—Permanence and Utility

BY H. COLIN CAMPBELL*

MORE marine terminals are needed to-day to take care of the enormous shipments of war materials and men, as well as for increasing export trade in every line. The present demand for terminals is not a temporary one, but will increase in the future rather than decrease. Boats are being built in large numbers and provision must be made for loading them rapidly. The use of concrete in this work in the past, its value now when terminals must be prepared in haste, and its possibilities for future construction are proper subjects for discussion in this journal.

Terminal facilities have always meant the development of a country, even as the lack has retarded progression. Venice was one of the first cities to take full advantage

* Director, Editorial Bureau, Portland Cement Association, Chicago, Ill.

Fig. 2.—Interior of Pier Shed, Thirty-Fifth Street Pier, New York, Showing Reinforced Concrete Deck and Steel Roof

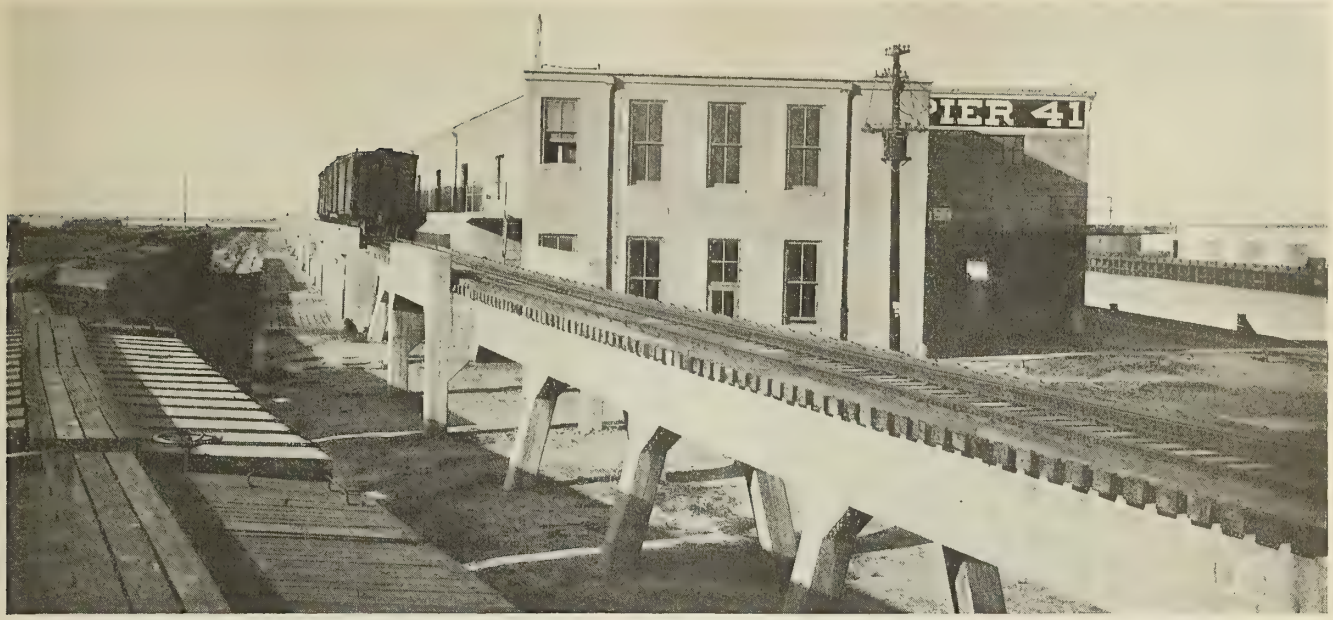


Fig. 3.—Pier No. 41, Galveston, Texas. A Reinforced Concrete Trestle Bridge Gives Permanent and Uninterrupted Track Service to This All Concrete Pier

of terminal facilities and its location made it ideal for unloading and distributing goods. For years the wealth of the world was carried by the Venetian ships. To-day, England owes much of her maritime prominence to the terminal facilities of the British Isles, and the United States must realize the importance of marine terminals to our industrial and national expansion. The broken shore line of our coast, particularly the Atlantic Coast, gives practically unlimited locations for terminals. The nature of the frontage, location of railways and lines of communication make construction difficult in some places, but, through the use of concrete, terminals have been and are being built, and concrete bridges, causeways, viaducts, and roads give access to them. Concrete sea walls, and breakwaters protect the harbors, and concrete lighthouses point the way to the safe channels.

Marine terminals are the logical result of a productive country, as well as of international commerce. To require or use imports, a country must be prepared to give

Fig. 4.—Concrete Pier Construction in San Francisco. Sub-Structure of Pre-Cast Concrete Pile

either raw material or manufactured goods in exchange. This implies facilities for loading and unloading boats and trains quickly and economically.

Terminal facilities include safety to boats while at the dock, and to the goods until they leave. This applies to shipments in as well as out. It implies safety from the tidal currents and sea dangers, as well as from fire, collision, etc. Goods must be kept dry, kept cool at times, yet at all times accessible. Safe passage to open water must be maintained. Some goods for some points must be held in storage until a boat is available, and therefore, goods must be packed to overcome the difficulties of shipping when port facilities are limited or practically nonexistent.

The diversity of products furnished by the United States or shipped from its ports and the variety of goods received necessitate a considerable variety of terminal facilities. To some extent these materials are localized, while in others they form the miscellaneous cargo. Galveston and New Orleans are prominent cotton shipping points. Duluth, Buffalo, and Chicago handle grain; Ashland, Wis., Cleveland, and Ashtabula specialize in ore; Baltimore and Philadelphia in coal; Portland and Seattle in lumber; New York, Boston, and Philadelphia in manufactured goods. Each commodity requires special facilities for economical handling, and yet each of these ports handles large quantities of other materials.

A similar condition is found in the imports. Boats from South American ports bring mahogany logs roughly squared—perhaps three feet square, sixty feet long, and weighing perhaps ten or fifteen tons. San Francisco unloads tons of Chilean nitrate. New York receives boatloads of bananas, oranges and tropical fruits. Other ports receive similar shipments, and the goods must usually be transhipped to the point of final destination. As a rule the larger the port from which a boat comes, the more general its cargo, while with exports the smaller the port of destination the more varied the shipments. Each terminal port must therefore be prepared, for this means that ships must sail in ballast or light, or seek other ports for a return load. Highly specialized lines, such as tank steamers, ore and grain boats, may have difficulty in obtaining return cargoes, but in the main the rule will be found true. The development of fixed markets has led to the establishment of liners, while the lack of regular cargoes has added to the number of "tramp" steamers.

Ideal marine terminals should therefore be prepared for the convenience of passengers, raw materials produced in the tributary district, such as cotton, grain, provision, coal, lumber, and building materials, machinery and equipment, as well as manufactured articles.

Location of Marine Terminals

The location of marine terminals is based on a number of conditions, some of which vary greatly in the methods used to make them efficient.

The first requirement is sufficient depth of water for the vessels which will enter the port. Assuming the ocean highway has a sufficient depth, the immediate locality may be dredged to the required depth. At some places where the range of tide is great, small vessels may rest on the bottom or on shelves constructed alongside the dock. At times an enclosed harbor may have tide gates to be opened only at stated tide heights; or locks by which boats may leave or enter practically free from ocean currents.

The locality should be largely free from currents, floating ice, wind and waves. It should have easy and safe access from the sea at all hours, and sufficient area to accommodate the heaviest probable traffic. This includes warehouses, storage bins, unloading space, railroad tracks, etc., necessary for economical operation. There should be freedom from labor troubles, particularly a shortage of freight handlers.

Fig. 5.—All Concrete, Fireproof Pier of Delaware, Lackawanna Railroad, Hoboken, N. J.

The first requirement practically means building the terminals from the bottom of the harbor. Some terminals have been built on solid ground, and the depth of water obtained by dredging, while others have been built on land a little above the sea level, the solid ground for foundation being obtained by dredging and filling; and some in relatively deep water. A combination method is usually the result when building a terminal of any size. A firm foundation must be found to provide for the weight of the buildings and docks, to resist the horizontal forces, such as the impact of vessels, currents, floating ice, etc., and the outward pressure of the soil. The project must also be economically practical.

Depending on the nature of the material to be handled, the terminal itself must be equipped with railroad and team tracks, trucking space, cranes and derricks for unloading, facilities for loading and unloading large and small boats, and for transshipment via cars and lighters and vice versa.

Goods in transit must be protected from the weather.

Fig. 6.—Concrete Cylinder Pier Construction at San Francisco

Thus a port shipping grain requires elevators for such protection as well as rapid handling. Food products fruit and vegetables, require cold storage. Bulky machinery, lumber, and finished woodwork must often have storage space and be covered with tarpaulins, etc.

Newark Port Development

Frontage on navigable water is so valuable that dockage can seldom be confined to frontage only. Cargo ships being 500 or more feet in length, it is manifestly a saving of space to construct slips between the docks, thus greatly increasing the capacity of a given frontage. A typical method of meeting this problem may be seen in the layout of seven 1,200-foot piers for the Newark Port development. The frontage is about 4,000 feet on Newark Bay, including a 400-foot ship canal. Dockage along the seven piers provides 16,800 feet of space, while one side of the ship canal furnishes an additional 5,000 feet suitable for transference to and from cars or lighters. A concrete retaining wall six feet thick at the bottom and eleven feet high holds the filling material dreged from the bay and pumped by a suction dredge a distance, in some instances, of over a mile.

A similar use of concrete may be found in the Hunt's Point Terminal in New York. Here 3,600 feet of bulkhead served to reclaim over 200 acres of swamp land. A block of concrete approximately seven feet thick and ten feet high retains the filling.

Victoria, British Columbia, solved a similar problem quite differently. A breakwater 2,500 feet long was built with a concrete core faced with granite. Two piers having berthing places for boats 800 and 1,000 feet long are built out into the harbor, the depth of the water being up to 60 feet or more. A foundation of rubble was built up to 35 feet below low water and reinforced cribs 35 by 80 feet and 39 feet high were built on shore, floated to place and sunk to the bottom. The crib was then filled with loose rubble. On top of the crib a concrete retaining wall is built to hold the fill. Somewhat similar cribs have been used at Copenhagen, Denmark, and in the new work of the Welland Canal.

New York Piers

Not all ports have unlimited water front area, however. The flow of rivers must not be unduly restricted, and the Government wisely limits the projection of piers, bulkheads, etc. The piers of New York, for instance, including the parts of New Jersey contiguous, have in many places reached the limit and recourse must now be had to extending the piers shoreward. This is expensive in many places, and particularly so in upper Manhattan. In the municipal pier in the North River at the foot of West 46th Street, over 200 feet of rock excavation was needed to provide 1,000-foot piers. The pier walls are concrete retaining walls varying from a minimum of 10.2 feet thickness, about 20 feet high to 23 feet thick, and 56 feet high. Forty-four feet of water is provided at the piers.

In the Chelsea District of Manhattan, piers were extended shoreward about 500 feet on land, formerly (about

1840) filled in and built up with factories, warehouses, etc. The inshore fronts of the pier sheds are concrete on expanded metal supported on steel girts. The possibility of settlement on the made land led to a construction in which any section might be jacked up when necessary.

When a great range in tides must be considered, it is found advisable to build enclosed docks large enough to take any vessel coming to that port, and provided with gates to prevent danger to the shipping, etc. Such a project is being built at Chemulpo, Korea, and consists of a dock 700 by 1,500 feet inside, provided with storage sheds and railroad connections, and inclosed basin, and a tidal lock connecting the dock with the outer harbor. Mass concrete is used liberally, the sides of the dock being on the average about 18 feet thick, 64 feet high, while the bottom is from 13 to 15 feet thick, reinforced with steel rails.

Lake Washington Canal Locks

A somewhat similar project is being carried out at Seattle, Washington, where a ship canal eight miles long is being built to connect Lake Washington with Puget Sound. This will give Seattle a fresh-water harbor of about 25,000 acres, with a shore-line about 100 miles long. A lock near the lower end of the canal will pass vessels 825 feet long, 80 feet in width, and drawing 36 feet; 200,000 yards of concrete will be used in the lock alone.

To provide additional anchorage and docking space, England has under consideration an almost parallel case at Loch Lomond in Scotland. A concrete dam and locks will permit sea-going vessels to use the lake for anchorage, while the shore line may be built up with the necessary repair shops, docks, and terminal facilities.

Breakwaters Built of Concrete

Concrete in the form of massive blocks is being increasingly used for building breakwaters and other protective works. The Panama Canal Breakwaters at Limon Bay, the Atlantic or northerly entrance to the Canal, are protected by concrete blocks from 4 foot 6 inches to 7 foot cubes. About 20,000 of these blocks were used for this purpose.

Considering the city of Galveston as a whole as a terminal, the harbor may be described as a lagoon between an island and the mainland. All the terminal facilities are on this lagoon, the city proper is on an island. The entire side of the island fronting on the Gulf of Mexico, exposed to the full sweep of the sea, is protected by a concrete seawall 16 feet high, 16 feet thick at the bottom and 5 feet wide on the top. This concrete wall saved the city and terminals from destruction in the great storm of August 16-17, 1915, although considerable damage was done to the causeway from the mainland to the island. The concrete warehouses, grain elevators, and terminal structures were comparatively unharmed.

Concrete Piles

Concrete piles for the support of docks and wharves at San Francisco illustrates a typical use of this material. During the last twenty years a large number of piles have been used for this purpose. The concrete is generally reinforced, and is either in the form of cylinders or piles. In the former the concrete is deposited in wood or steel forms and hardens in place; while the latter are cast in a convenient locality, seasoned from 30 to 60 days, and driven by pile drivers, steam hammers, or water jet. The latest practice in building cylinder piers is to use a steel form about three feet in diameter, which is withdrawn after the concrete has sufficiently hardened. The concrete piles, in general, are preferred in San Francisco, as any defects are more readily apparent.

Piles used in this work have been made as long as 106 feet and as large as 20 inches square, and have given complete satisfaction. A minimum depth of water of 33 feet is provided, while in some places the ends of the piers are in water 50 to 70 feet deep. The piles are cast in suitable yards and allowed to harden about 30 days before being driven.

Docks on New York Barge Canal

Terminal docks of the Barge Canal at Albany, New York, consist of docks formerly in use, to which was added a reinforced concrete sheet-pile bulkhead, having Raymond concrete piles about 25 feet long capped with large blocks of concrete driven some 20 feet back of the bulkhead and anchored to it with steel ties.

At Troy a concrete retaining wall extends to the bottom of the canal, while at the Western terminus at Buffalo, a portion of the wall is timber cribbing filled with rubble and topped with 8½ feet of continuous concrete wall. The lower 3 feet is of concrete blocks 6 by 10 by 3 feet, the top 5 feet being cast in place.

London Marine Terminals of Reinforced Concrete

The Port of London Authority, established in 1909, has already effected many and great improvements in the new port of London, providing facilities for handling both passengers and freight. Buildings for many purposes have been erected or are in process of erection, and three of the latest buildings are for cold storage, refrigerating station and transit shed. These are all practically reinforced concrete, resting on 30-foot concrete piles, 12 to 16 inches square. The cold storage building is 307 feet long by 100 feet wide, six stories high, the framework of reinforced columns and beams having brick panel wall filling for external and cross walls. Reinforced concrete beams 40 inches by 14 inches run longitudinally through the building connecting the bases of the columns and supporting secondary beams 18 inches by 9 inches which carry the floor slab.

The columns on the ground floor are 24 inches by 24 inches, and reduce in size regularly to the fourth floor where they are 18 inches by 15 inches. The main beams are generally 30 inches by 18 inches with 16-inch by 10-inch secondary beams.

The transit and cold storage shed is 1,000 feet long by 123 feet wide, also designed with reinforced concrete pile foundations, beams, columns, and floors. The floor is designed to carry 300 pounds to the square foot, and a feature of the shed is the cartway area 100 feet wide. Reinforced concrete girders of 50 feet span carry the second floor load as well as crane loads of 33 tons.

Ocean Steamship Terminals at Halifax

Concrete was largely used in the construction of the ocean steamship terminals at Halifax, N. S. Provision was made, on a 6,000 foot frontage, for six piers 340 feet wide and 1,250 feet long, separated by basins 350 feet wide and 45 feet deep. Berthing space is provided for 27 large steamers. The sides of the piers are built up of hollow concrete blocks 22 by 31 feet, 4 feet high.

We have mentioned only a few of the features of some of the most recently built terminals. The part which concrete has taken in each one would require a volume in itself. For the future we can only see a greater use of concrete than in the past, for its merits are well known, its qualities have been proven, and its economy is apparent.

Marine Terminal Engineering

Lecture Delivered Before the Electrical Engineering Institute Section, Sheffield Scientific School, Yale University

BY H. MCL. HARDING*

TERMINAL engineering includes that branch of engineering pertaining to port development, except that which is strictly harbor engineering and which now is for the most part under the jurisdiction of the engineers of the War Department of the United States.

Increase of Domestic and Foreign Commerce

The following figures indicate the great increase in the domestic and foreign commerce of the United States since 1914.

The congestion which has resulted from this great increase and which is so disastrous to the business of the United States, is due to the inefficiency of terminals. These terminals being inadequate have clogged the railway transportation system of the country, and while this congestion has seriously affected all classes of freight, that pertaining to fuel is the most acute. Before 1914, there was congestion from any comparatively small increase of traffic at most of the railway terminals, and the late James J. Hill, the president of the Great Northern Railway, long before he died, predicted the present condition, and stated that to bring up the terminals to an equality with the rest of the railway equipment (meaning cars and tracks) would require a terminal investment of more than eight billions of dollars.

Before the present war, there was about 4,000,000 tons of shipping in the United States. Within the next three years there will be more than 16,000,000 tons.

In 1900, the value of the home trade of the country was $11,700,000,000 (£2,400,000,000), for 1914 it was $29,900,000,000 (£6,140,000,000), and for the year 1917, $64,100,000,000 (£13,120,000,000).

In 1900, the foreign trade was $2,307,095,827 (£473,000,000), in 1914 it was $3,902,000,000 (£800,000,000), and in 1917, $9,050,000,000 (£1,850,000,000).

From the above figures of the increase in domestic and foreign trade, it is evident that the present number of marine terminals will be greatly increased within a few years, and that the railway terminals must be equipped with the latest electrical freight handling machinery, whereby the freight handling capacity of a given area of ground can be doubled or trebled. To correctly equip these terminals calls for the highest class of electrical engineering.

Number of Marine and Railway Terminals

There are to-day over 3,500 marine and river terminals in the United States, and in addition, according to Mr. Fairfax Harrison, president of the Southern Railroad, between 250,000 and 300,000 railway terminals or freight stations. The port of New York is counted as one terminal. Many marine terminals are combined marine and railway terminals.

Electrical Adaptation

At many of these terminals there will be the adaptation of electricity and especially as pertaining to the transferring and handling of cargoes and freight.

The number of marine and river terminals will be greatly increased, possibly doubled, within the next two years, on account of the coming merchant marine of the United States and the greater utilization of river and canal transportation by power boats and barges.

Few railway or marine and river terminals are now properly equipped.

This new adaptation of electricity to terminals is a comparatively new industry and opens up a new important field for invention, design and initiative, and affords probably more opportunity for quicker personal advancement than does any other branch of engineering.

Terminal Investments by Cities

The investment in marine terminals, especially by municipalities, often runs into millions, but it is a paying investment and adds nothing to the tax rate, often reducing it. The following list of cities is an evidence as to the terminal activities, whereby cities and states are constructing terminals for future ownership, control and operation.

Cities Constructing Terminals

Boston, Mass.	Elizabeth, N. J.
New Bedford, Mass.	Perth Amboy, N. J.
Providence, R. I.	Camden, N. J.
New York, N. Y.	Jersey City, N. J.
Trenton, N. J.	Newark, N. J.
Philadelphia, Pa.	Chester, Pa.
Baltimore, Md.	Jacksonville, Fla.
Buffalo, N. Y.	Wilmington, Del.
Superior, Wis.	Cleveland, Ohio.
Chicago, Ill.	Montgomery, Ala.
Mobile, Ala.	Orange, Tex.
Port Arthur, Tex.	New Orleans, La.
Beaumont, Tex.	Pensacola, Fla.
San Diego, Cal.	Los Angeles, Cal.
Oakland, Cal.	San Francisco, Cal.
Richmond, Cal.	Portland, Oregon.
Seattle, Wash.	Tacoma, Wash.
Astoria, Oregon.	St. Louis, Mo.
Minneapolis, Minn.	St. Paul, Minn.

The above list is receiving additions nearly every week.

Terminal Principles

For those electrical engineers who were called upon to design and construct terminals, as well as city authorities who are considering the development of their waterfronts, the following method of procedure may be of service:

In designing all new terminals, the harbor line having been determined, there should be a comprehensive layout which should indicate all future units and be a plan which can be followed during many years in the future, when extensions are made.

To be successful, it must be designed from the electrical freight handling standpoint, and not from the use of the two-wheeled hand truck.

Terminal Elements

The elements of a marine terminal consist of piers, slips, quays, railroad tracks and various railway yards,

* Consulting Engineer for the State of New York on Barge Canal Terminals.

sheds, warehouses, dray areas, open storage spaces and often public markets, cold-storage buildings, coal pockets and manufacturing lofts. There are also administration buildings, warehouses and open areas for special commodities.

Freight Movements

The following are the principal freight movements which require electrical appliances:

(a) Between the ship and the open pier, the open quay and the shed or warehouse.

(b) Between the ship and other ships or vessels (transshipments).

(c) Between the ship and cars (outbound freight).

(d) Between the shed and the warehouse.

(e) Between the ship and dray and open areas.

(f) Between the cars and terminal buildings.

(g) Between any of the buildings or areas within the terminal lines.

Terminal Units

Although the marine terminal consists of these many elements, yet for convenience in financing, in construction, and in operation a terminal is now divided into unit sections, each section being a complete workable, income-producing terminal unit, similar to the other units, which are to be added as traffic increases but without change in the first unit.

At different ports, with quay construction, the chief variations in units would consist in the size of the elements and in the length of the lineal berthing feet apportioned to a unit. The length of this unit frontage is determined by the maximum length of the freighter which will use the unit.

Size of Units

Such a unit would therefore contain, for an inland river terminal, for freighters of 500 feet in length, of a berthing frontage of 500 feet of quay wall, a shed of a length of 400 feet, a warehouse the same length as the shed, but wider, the quay, the shed and the warehouse served by railway tracks and mechanical appliances.

An inland river terminal unit for barges of not over 350 feet in length would consist of berthing frontage 350 feet long, a shed 300 feet in length, and a warehouse also 300 feet in length, equally well served by railways and machinery.

For the larger ocean ports, each unit should be 600 feet in length, but there should be two units adjoining in one straight line so as to berth two ships, each of 600 feet, or an ocean liner 1,000 feet or more in length. The shed should here be 500 feet long and the warehouse 500 feet.

The port works, for convenience, may be separated into two divisions, the substructures and the superstructures; the port facilities, into railway tracks, railway connections, motor trucks, electrical appliances, universal or overhead cranes, carriers for miscellaneous cargoes and special electrical appliances.

Substructure in Terminal Construction

This substructure, to avoid interruption in commerce, should be permanent, that is, safe from fire, rat proof and decay-resisting.

Fresh Water Quay Terminals

As many of the new ports are inland, where the water is fresh and free from teredo and other destructive agencies, there are given a few detailed views of an adaptable type of construction.

In this type, all wooden piles or platforms are always below the mean low water elevation, and above this elevation is a permanent concrete wall and behind the wall and above the relieving platform is a filling of earth, sand or cinder, securely paved with concrete and asphalt.

Relieving Platform

As is well known, it has been, in the past, difficult, except at an enormous expense, to construct a permanent quay wall, which would not be pushed out of alinement by the earth pressure. At a depth of 40 feet this pressure is often 20,000 pounds or more per square foot.

The natural slope of the earth is not disturbed if at about 1 on 2 slope. This natural slope is blanketed by riprap at 1 on 1 slope, to prevent washing or erosion caused by the movements of the ships, seepage, or heavy rains.

The piling being always below low water, is driven into this unchanging natural slope, and above and supported by these piles are cross caps and the grillage or relieving platform, all of great strength, sustaining the concrete wall and the paved filling.

There is, therefore, visible, an indestructible, smooth, solid concrete gravity wall, some seven or more feet wide at the base and three or four feet wide at the top. (These dimensions vary according to the height of the wall.) The piles below the water are always saturated and will not burn or decay.

The installation cost is not much more than that of an inflammable wharf of creosoted piles and wooden flooring.

Teredo-Infested Waters

In case the water is salt, infested with the usual teredo, then the piles and the relieving platform are of concrete.

In the case of projecting piers, as into a harbor or large turning basin, the construction is the same, but is equivalent to two quay walls, one on each side of the pier, back to back, with a solid or pile center between.

The pile center is used where the volume of the flow of the river must not be obstructed.

Shed Capacity

It is a good rule to plan the shed for such a capacity that it will be possible to distribute all the goods taken from one ship berthed opposite to it. This is the rule at Hamburg, Germany.

When goods are handled by hand, the average height of tiering or piling averages about 5 feet. It is, therefore, evident that there would be required a very large floor area to distribute and place a cargo of 6,000 tons, according to the marks and cross marks, especially if a miscellaneous cargo.

Tiering either 15 feet or 20 feet is necessary to avoid too great an expense for land areas, to shorten the frequent movement in the shed, to reduce the initial investment in the shed, to prevent the installation of tiering and other machinery to be installed.

Terminal Buildings

At every quay terminal there should be two principal classes of buildings, having entirely different functions; one is the shed and the other the warehouse. These are of different design and construction.

Transit Shed.—The transit or transfer shed should be a steel structure, comparatively narrow, but high studded, twenty-five to thirty feet under the trusses, one story and well lighted in every part. Its length is about equal to four-fifths of the length of the longest freighter, which will berth opposite to it, and its storage capacity equal to two cargoes of such a freighter. It is for the handling of cargoes and a place of intense activity, for the tem-

porary holding of goods for not more than 48 to 72 hours. It is not a storage warehouse.

Warehouse.—The warehouse is of four to six stories in height, somewhat wider than the shed, of concrete construction, a building for as long storage as may be desired. Goods therein stored are to be kept safely.

The warehouse being for long storage, often of months' duration, since the goods may not be moved during this time, should not usurp the position or function of the transfer shed, but should be placed to the rear of the shed and parallel to it for the shortest and the easiest movements between the two buildings.

Railroad Connections

There should be two or three railway tracks between the shed and the quay wall and other tracks to the rear of the shed.

Electrical Appliances

These appliances are divided into two classes, the first external for transferring, that is, for discharging and loading the vessel, and the second internal for handling, that is, assorting, distributing and tiering.

For transferring miscellaneous cargoes, there are used the full or half arch traveling gantry jib cranes of from two to five tons capacity at 200 feet per minute hoisting speed, with an outreach of 50 feet at 50 feet above the quay wall, with a lift of 80 feet. The same crane can be used for both two tons and five tons—two tons at an outreach of 50 feet, and five tons at an outreach of 20 feet.

All three or four movements are performed by separate electric motors at a minimum of cost for transferring.

By means of these cranes, outbound freight can be swung from the car to the vessel.

Inbound freight, however, must be distributed and tiered, and therefore, in general, the movement by the crane is to or within the doors of the shed from the ship. This distribution between the movements of the outbound and inbound freight is important.

To supplement the gantry crane service, and to prevent the usual congestion, either outside or within the shed, there are electrical traveling bridges similar to shop cranes.

Other Electrical Freight Handling Types

There are many other types of hoisting and conveying appliances installed at marine terminals, but these, as a rule, are designed for special commodities and not for universal application. It is possible only to enumerate the most important. Portable electric dock winches; stationary electric dock winches; floating steam hoists or electrical hoists; floating grain elevators; whip hoists; traveling unloaders, 5 to 10 tons capacity; elevated stationary hoisting winches; pillar cranes; locomotive cranes; stationary bridge cranes; lifting towers and belt conveyors; derrick booms and grab buckets; coal dumps on tipples; barrel conveyors and elevators; gravity chutes and conveyors; bag and box chutes; baggage escalators; motor trucks; cargo chutes; blind-hatch hoists; stationary cranes, hammer type, of great capacity.

Almost without exception these are electrically operated.

Terminal Designing

It is evident from the above, that the terminal works, including substructure and superstructure, must be correctly planned and the electrical appliances and other facilities properly adapted to the work, with sheds and warehouses rightly proportioned to the size of the ships, and the railway tracks co-ordinated for direct transference between water and rail and the ship and the shed.

The example herein given, as to the cost of a terminal quay, will indicate the advantages attained by following terminal principles. Similar advantages can be secured in other designs and layouts, as in shed construction and methods of operation. The data from the following mentioned ports are official.

Certain portions of some of these ports were improved and other portions were allowed to remain without change. There were also the reports covering the whole waterfront of these ports for a number of years before any improvement had been made, which figures are used for comparison.

The figures represent actual conditions and the tonnage of the cargoes transferred during a number of years.

	Tonnage per linear yard per year	
	Before Improvement	After Improvement
Havre, France	385 tons	1,430 tons
Marseilles, France	665 tons	1,694 tons
Rouen, France	483 tons	1,121 tons

At the present day, still further advances have been made in design and improved mechanisms, which will increase the tonnage of the improved sections still further over those of the unimproved sections.

From the above data and similar reports, the superiority derived from the improved designs and mechanisms is in the ratio of about 450 tons per linear foot frontage per year for the improved sections to 150 tons per linear foot for the unimproved sections.

To transfer and handle 150,000 tons per annum would require a linear frontage of 1,000 feet at 150 tons per linear foot. At 450 tons per foot, there would be required only one-third the length of frontage or quay, or 333⅓ linear feet. This 333⅓ linear feet, all things being equal, would require an initial investment of one-third of what would be required for 1,000 feet, to handle an equal tonnage of 150,000 tons in a year. There would be better facilities and equipments on the 333⅓ linear feet, so that the investment for the 333⅓ would average about one-half the terminal quay cost for the 1,000 linear feet.

If there be taken into consideration the purchase price of the land, the dredging from the river channel to the quay and other conditions, it will be seen that the cost for the 1,000 feet will be much more than twice the investment for the 333⅓ feet.

Conclusions

First: For all ports, those harbor works, terminal facilities, operating methods, and electrical appliances should be adopted which have proved most efficient in respect to time and economy of cargo transference and handling.

Second: That all new terminals for inland and ocean navigation should be so designed, planned, and proportioned in respect to the piers, quays, sheds, warehouses, and railway tracks, as to secure easy, quick, and economical interco-ordination between all these terminal elements and with the water carriers.

Third: That not only should the world's best be adopted and then adapted by terminal engineers to the operating conditions of each location, but terminal engineers should continually study to achieve something better.

Fourth: That the securing of the greatest speed possible in all marine freight terminal movements is of all terminal features that which is most essential.

Fifth: Any port which hopes to secure its share of domestic and foreign commerce must build permanent and fireproof quays and piers and such as will not be liable to an embargo on account of epidemic.

Sixth: No port and its hinterland, with its factories, mines and farms, can even hope to hold its present position

if a large seaport, or to attain to its rightful heritage, unless it provides the terminal facilities, as sheds for temporary holding, and electrical freight moving machinery to attract the shippers, consignees and shipowners, and have available warehouses for long storage.

Seventh: Its chances of holding even a rear position in the race for supremacy are small indeed, unless it has complete electrical co-ordination between rail and shore, according to the best designs and plans.

Eighth: A terminal quay of modern design and correctly equipped for rapidly transferring and handling a given tonnage of freight within a given time will require an investment of about one-half that usually required and can be constructed in one-half the usual time.

Ninth: No port to-day can afford to ignore terminal engineering principles if it is to secure and retain its share of foreign commerce. A merchant marine without terminals is like a railroad without freight stations.

How Modern Welding Processes Save Time of Ships in Dry Dock for Repairs

Some Recent Achievements by the Thermit Process in the Quick Welding of Heavy Sections

NOW that the call is for ships, ships, and yet more ships, it has been necessary for marine engineers to turn their attention to the quick repair of vessels as being of almost equal importance to the rapid construction of new tonnage. It is self-evident that if a vessel can be repaired and taken out of dry dock in two or three days by utilizing one of the modern welding processes it would be a crime to keep the vessel in dry dock for any longer period and make the repair by the old-fashioned methods, which are now practically obsolete, and which are still adhered to by only a few engineers of the fossil variety. The German ships would still be out of commission if the Government had not utilized modern methods.

The thermit welding process is one of those which has come very rapidly to the front within the last few years, as it is the only process which has consistently and successfully welded the heavy sections of a vessel which occasionally break, such as the stern frame, the rudder frame, the rudder stock, the tail shaft or crank shaft. All these sections are much too heavy to be successfully repaired by either oxy-acetylene or electric welding, the reason being that in the case of both these processes the metal is fused in only drop by drop, and it has been found impossible to prevent the formation of innumerable internal shrinkage strains, which invariably cause trouble later on. The only reason thermit was not used in repairing the German ships was because the Germans did not break any sections sufficiently large at the fracture to require a thermit weld.

The principal reason for the success of the thermit process in the welding of heavy sections is due to the fact that the metal to make the weld is produced in bulk at the exceptionally high temperature of 5,000 degrees F. The weld is achieved by pouring this superheated liquid steel around and between the parts to be welded together. It then melts those parts up and thoroughly amalgamates with them to produce a single homogeneous section when cool.

For the benefit of those who may not be familiar with the details of this process, it might be well to state that thermit is a mixture of aluminum and iron oxide. This mixture can be ignited at a temperature of about 3,000 degrees F. upon which a chemical reaction takes place. The aluminum burns, and in so doing takes away the oxygen from the iron oxide, thus setting the iron free. This iron is precipitated as a mild, low carbon steel. The aluminum oxide formed by the reaction floats on top of this steel in the form of a slag, and the temperature of both

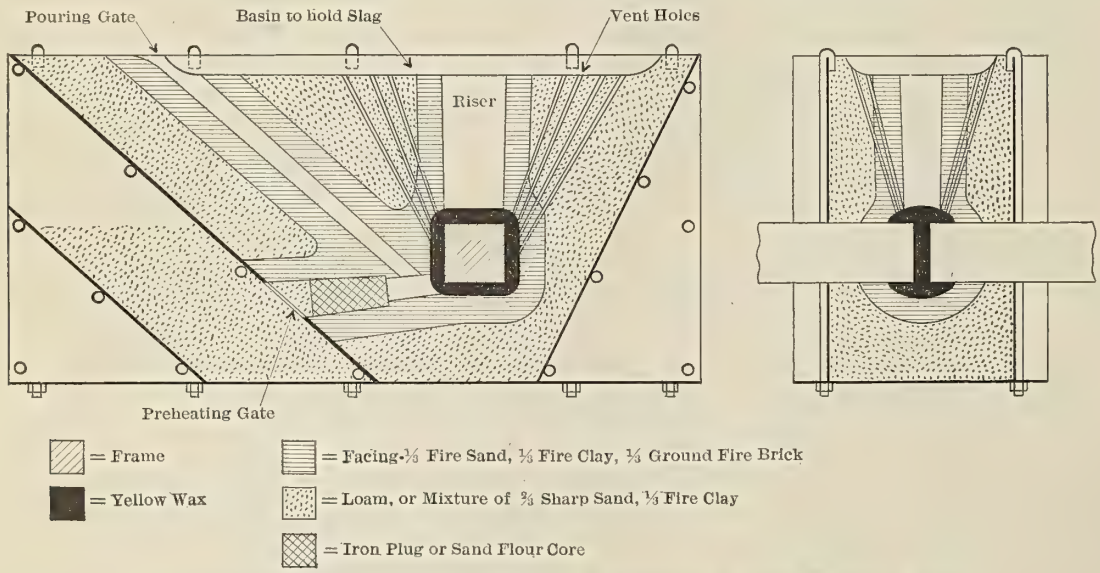

Pouring Gate
Basin to hold Slag
Vent Holes
Riser
Preheating Gate
= Frame
= Yellow Wax
= Facing-⅓ Fire Sand, ⅓ Fire Clay, ⅓ Ground Fire Brick
= Loam, or Mixture of ⅔ Sharp Sand, ⅓ Fire Clay
= Iron Plug or Sand Flour Core

Fig. 1.—Construction of Molds and Materials Required for Making Thermit Welds

Fig. 2.—Stern Shoe on S. S. *Henry Stienbrenner* of Kinsman Transit Company, Welded July, 1917

slag and steel has been calculated at about 5,000 degrees F. Thermit gives half its weight in steel, but the quantity of steel, as well as its quality, is increased and improved by the adding of certain metals and additions to the thermit powder. In practice, about 15 percent mild steel punchings is mixed with the thermit, together with ⅝ percent nickel shot and 1 percent pure manganese. With these additions, thermit gives about 65 percent of its weight in a very high quality of steel.

In practice, a thermit weld is made by first separating the parts to be welded together from one to two inches, depending on their size. In the case of a stern frame of a steamship this space is cut out, utilizing the oxy-acetylene cutting torch for the purpose. A pattern of yellow wax is then shaped around these sections of the exact form of the collar or reinforcement, which is to be cast around them out of thermit steel. A sand mold is then formed around the wax pattern, using a special refractory molding material to stand the high temperature of the thermit steel. Wooden patterns are, of course, used for the pouring gate and riser, as well as for a small, preheating opening on one side. The general cross-sectional view of a thermit mold is shown in Fig. 1.

With the mold completed, the flame of a gasoline (petrol) compressed air torch is directed into the preheating opening, and this serves to melt out the wax, leaving the mold ready for pouring the thermit steel. The heating is continued, however, for a considerable period of time after the wax is melted out, in order thoroughly to dry out the mold and bring the parts to be welded to a red heat.

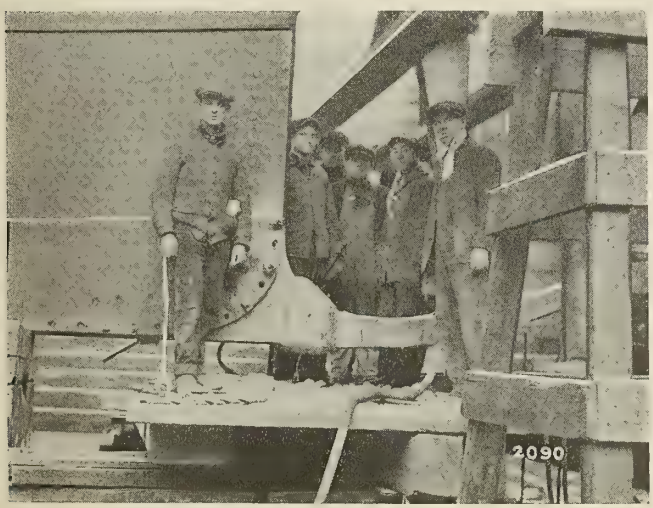


Fig. 3.—S. S. *Chas. O. Jenkins* of Jenkins Steamship Company. Section 14 by 18 Inches, Welded November 10, 1917. 700 Pounds Thermit Used. Time Used in Making Repair, 37 Hours, 10 Hours Preheating.

At this time the thermit charge is ignited in a crucible suspended over the pouring gate, and when the reaction is completed, which takes from 30 to 40 seconds, the crucible is tapped, allowing the thermit steel to flow into the mold, thus completing the weld. The mold is usually left in place over night, in order to allow the weld to cool slowly, after which it can be dismantled and the excess metal in the pouring gate, preheating gate, riser, etc., removed by means of oxy-acetylene.

Welds on steamers can usually be completed inside of 48 hours by this process, one day being required for ramming up the mold, preheating and pouring, and another day for cooling and dismantling. It is seldom that more than three days is required.

What this means to steamship companies can readily be appreciated when it is remembered that in previous years it has almost always been necessary to remove a broken stern frame from a vessel and either install a new one or else repair the old one in a blacksmith shop and replace it in the vessel. A repair of this nature could never be completed inside of several weeks' time.

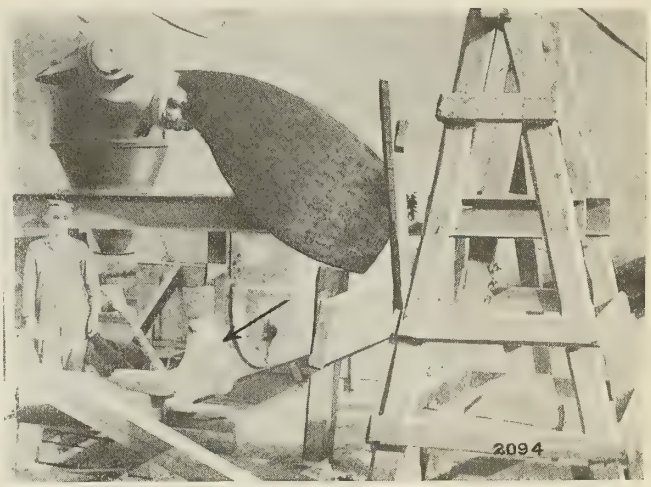


Fig. 4.—S. S. *Sierra* of Inter-Ocean Steamship Company. Section of Stern Shoe, 11⅝ by 16 Inches, Welded September, 1917

Thermit process has been utilized for many repairs on the Atlantic Coast, as well as on the Great Lakes and at Pacific ports. The accompanying illustrations show a number of the repairs which have been completed most recently.

The non-compressibility of water, coupled with the thickness of some men's heads, has helped the repair shops to several millions of dollars of work. We cannot change the nature of water, but we can do something with the men's heads.

A book will tell you how to open or close a throttle, but that operation is not all there is to starting and stopping an engine. You can get information from books, but never skill.

Every engine has its cylinder cover insulated, of course, but how many engines have you seen where the lower end of the cylinder is half as well guarded, if at all, as the cylinder cover?

The Preservation of Wood in Connection with the Building of Wharves and Docks

Advantages of the Creosoting Process—Treatment of Timbers for Dock Construction—Increased Cost Offset by Longer Life

BY HERMANN VON SCHRENK*

THE preservation of wood has been used for a great many years in connection with the construction of wharves and docks in various parts of the world. Its extensive use first came about in England in the early part of the nineteenth century, particularly on the part of the British Navy. The increasing scarcity of good timbers for dock and ship construction led to investigations as to methods of increasing the length of life of timbers for marine work. The extensive use of artificially preserved wood did not come into general use, however, until the middle of the last century, and may be said to have begun with the issuance of a patent in 1838 to John Bethel, who was the first one to use creosote oil extensively in the artificial preservation of timber.

Bethel's early work soon showed what remarkable results could be obtained from well preserved wood, and gave rise to the construction of numerous plants in England. In the United States the first timber-preserving plant was erected in 1860, although the first plant for the treatment of marine timbers was probably the one erected by the Louisville and Nashville Railroad in 1875 at West Pascagoula, Miss. This was shortly followed by a plant at Long Island City, N. Y., by Eppinger & Russell Company, in 1878; the New Orleans and Northeastern plant in 1879 at Sliddell, La.; the Norfolk Creosoting Company's plant at Norfolk, Va., in 1896, etc.

Reasons for Creosoting Timber

In the United States the scarcity of timber had little to do with the impetus given to the creosoting of timber. The chief cause for its rapid development, particularly for marine work, was doubtless due to the high cost of replacing defective timbers after only a few years of service.

The short life obtainable from untreated timbers is due to two causes: (1) Decay, and (2) the attack by marine borers. Two forms of timber should be distinguished in any discussion of this subject—namely, piling and other timbers in direct contact with the water and timbers above the water line. Both piling and other timbers are subject to decay, due to various wood-destroying fungi. The extent and rate of destruction will depend largely upon the class of timber used. Round piling, with its ring of undisturbed sapwood, is particularly subject to decay, because the conditions under which it is used are very favorable for the growth of the wood-destroying forms. Hewn heart piling, which was frequently used in the early days, has a very much longer natural life, particularly the highly resinous yellow pine piling used along the Atlantic and Gulf Coasts. At best, untreated round piling will give only a very short length of life, and, as stated above, the replacing charges are very high.

The destruction of piling due to marine borers is very much more serious than the destruction by decay. The various marine organisms, including what are commonly known as ship worms, namely, the teredo (*Xylotrya*) and the crustacea (*Limnoria, Chelura* and *Sphaeroma*), have been the subject of much critical study during the past ten years, and their methods of attack and the manner in which they destroy wood are fairly well understood at the present time. They work most rapidly in warm waters, notably at points south of Norfolk, along the Atlantic Coast and on the shores of the Gulf of Mexico, and they are particularly active in the warm waters of the North Pacific. Dock timbers, meaning by this timbers used for the superstructure, will be destroyed by fungus decay, the rate depending largely upon the method of construction. Where timbers are enclosed so that high humidity prevails decay will be comparatively rapid, particularly if any amount of sapwood is present. Notable instances of this sort occurred within recent years in New York harbor, where the docks were entirely enclosed by means of thick oak planking placed all around the wharf to below water line for the purpose of fire protection. Numerous masses of fungi developed on the underside of this wharf, but were fortunately discovered before any serious damage was done.

Advantages of Using Chemically Preserved Wood

The great advantage of using chemically preserved wood is that all of the qualities of the timber are retained, and in addition thereto both the attacks from marine organisms and the destruction due to fungus decay can be largely prevented.

While a good many processes have been tried for the preservation of wood, there is practically one process which has stood the test of time when applied to piling and timbers for dock construction, and that is the creosoting process usually known as the full cell or Bethel creosoting process. The creosoting of dock timbers is carried out at a creosoting plant. Of these, there are now a large number on the Atlantic, Gulf and Pacific Coasts, and in England a similar number is situated within easy reach of salt water.

Creosoting Plant

A creosoting plant usually consists of a seasoning and storage yard and the creosoting plant itself. The piling and timbers are brought into the storage yard shortly after being cut in the forest. They are carefully piled so as to permit of rapid air seasoning. The creosoting plant itself is composed of one or more retorts or treating cylinders approximately 6 to 7 feet in diameter and 100 to 150 feet in length, provided with steam coils and tracks. In addition, there are a series of pressure, vacuum and air pumps, storage reservoirs for the preservative, measuring gages and dials to control every step of the operation.

In the Bethel process the air-dried timbers are pushed into the treating cylinder on small cars, and after the closing of the door a vacuum is produced. Where for reason of speed it is not possible thoroughly to air season the timbers and where it is necessary to treat green timbers, they are first subjected to a steam treatment. After the creation of a vacuum the creosote oil, at a temperature of 150 to 200 degrees F., is run into the cylinder until it is

* Von Schrenk and Kammerer, St. Louis, Mo.

completely filled and is then forced into the piling or timber until the best practicable impregnation is secured. The sapwood in all cases should be thoroughly penetrated. The oil left in the timber will depend somewhat upon where same is to be used. In northern waters, where the activities of the marine organisms are slight, 12 to 15 pounds are usually considered sufficient. In the warm waters of the tropics and along the Pacific Coast as high as 24 pounds are injected. Wherever possible the creosoted piling should be seasoned about three months before driving.

Timbers Should Be Bored and Framed Before Treatment

It is of the utmost importance that, if not impracticable, all timbers be bored and framed before actual treatment, so as to avoid injuring the creosoted layer during actual construction of the wharf. Many failures of so-called creosoted timbers have doubtless been due to failure to observe this precaution. Where it is necessary to expose untreated wood, for instance, after sawing off the tops of piles, after driving, the exposed surfaces should be given preferably two coats of heavy heated creosote oil. In the same manner creosoted oil should be injected into bolt holes or other injuries which are unavoidable. Where timbers are not exposed to temperatures exceeding 180 to 200 degrees F. the strength of the treated timber has been found to be practically the same as the untreated timber. In other words, creosoted piling and creosoted timbers can be used with exactly the same stress figures as for untreated timbers of the same character.

Different species of wood can be used. In the past the principal species used have been as follows: Southern pine along the Atlantic and Gulf Coasts and tropical countries tributary thereto; Baltic pine in England and other European countries; and Douglas fir, along the Pacific Coast.

Advantages of Creosoting Process

One great advantage of the creosoting process is that grades of timber can be used which otherwise could not possibly be employed in an untreated condition. A high percentage of sapwood is a desirable factor in timbers to be used creosoted, while they would be practically valueless in an untreated condition. Such pieces usually have a lower first cost than all-heart pieces. The usual grades for timbers are square edge and sound, except where excessive strength is necessary, in which case the grade dense pine (see standards, American Society for Testing Materials) should be used.

Creosoted timber docks will cost more than untreated docks, but in view of the very much longer life they are cheaper in the long run. A study recently made in connection with dock construction by the city of Chicago is of interest in this connection. Two docks were built, one a concrete dock along the collateral channel of the Sanitary District at the Marshall Boulevard municipal plant; the other a creosoted timber dock at Slip "A" of the Twenty-second street pumping station. In the creosoted dock all piles, capping, wales, stringers, sheet piling, battens and back logs were creosoted with 12 pounds of creosote oil per cubic foot. The cost of these docks, including excavation, but not including dredging, was: Concrete dock, $56.10 (11/13/9) per lineal foot; creosoted timber dock, $28.72 (5/19/18) per lineal foot. Quoting from Technical Letter No. 7 of the National Lumber Manufacturers' Association:

"For the purpose of mooring boats and loading and unloading, the docks are equally efficient; that is, from a strictly utilitarian point of view, either dock will serve the purpose.

"From the esthetic viewpoint, or for the purpose of carrying out some general architectural plan, the more expensive concrete dock might be favored.

"Assuming a conservative life of thirty years for the creosoted timber dock, a half century of service could be reasonably expected at the cost of the concrete dock. Therefore, from a purely economic viewpoint, if the cost of these two docks is indicative of what might be expected in this locality, the concrete dock must be classed as a luxury when compared with the creosoted timber dock. Moreover, the creosoted timber dock is more easily altered, is less likely to injure boats, and has a greater salvage value if developments require its removal."

In the foregoing quotation a life of thirty years is taken for the creosoted timber dock. This is an extremely conservative figure, in view of the experience of the past 75 or 100 years with the creosoted dock construction. Fig. 1

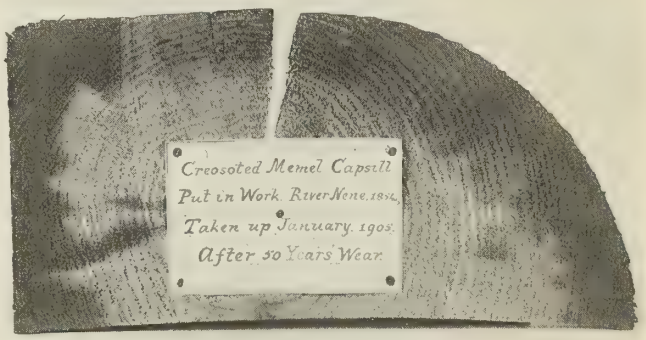


Fig. 1.—Section of Baltic Pine Creosoted Timber After 50 Years' Service in a Dock

shows a section of Baltic pine timber from one of the wharves of the British Navy Department on the River Nene, removed at the time of the reconstruction of the wharf. This dock had been in service 54 years at the time the writer made an inspection of this wharf, and practically all the timbers were in as sound condition as when first placed. Instances of this sort might be multiplied from all parts of the world. While there have been failures, these have doubtless been due to poor workmanship or improper construction. Thoroughly creosoted timbers have never been known to decay, and while the life of creosoted piling is probably not as long as that of timbers above water, particularly in tropical waters, 30 to 40 years' length of life may safely be assumed where a sufficient quantity of oil is injected and where the work is efficiently done. Contrast with this the service of untreated piling in Southern waters not to exceed twelve months.

Fire Risk

A word should be added as to the fire risk. Wooden wharves have burned in many instances in the past, and no discussion of wooden construction of wharves is complete without including this important subject. Creosoted timber and creosoted piles have a lower fire hazard than similar untreated timbers, irrespective of the species of wood of which they are constructed, particularly after they are four or five months old. Where proper conditions obtain they will undoubtedly burn, and when once thoroughly ignited a creosoted wharf will make a fierce fire. Prevention of fires in creosoted wharves, however, is an easy matter, provided proper attention is given to

design. Fires may occur either from the top of the wharves or from floating inflammable matter. By constructing tight docks much of the fire risk from above may be avoided, and the same is true when it comes to preventing ignition from below.

One of the chief causes of ignition of untreated wooden docks has doubtless been due to the formation of rotten holes and pockets containing tinder-like material which is easily set glowing by small sparks. Such pockets never form in creosoted timber, but the wood must start burning by direct ignition. In view of the fact that the kindling temperature for creosoted timber is very much higher than for untreated wood, it will readily be seen that the creosoted dock is a lower risk than the untreated dock.

Another phase obtained as a result of practical experience is that, while in many cases creosoted piling may take fire, these fires go out more rapidly of their own accord than is the case in the untreated material. Striking instances of this sort have happened during the past ten years, many of which came under the writer's personal notice. It is safest, however, to take all precaution by proper designing, so as to protect creosoted construction as much as possible.

The application of fire-resistive paint has done much to lessen the fire hazard. The chief conclusion to be drawn is that with proper designing a creosoted wooden dock may safely be considered a low fire-hazard structure.

In addition to the construction with piling and timbers which have been mentioned, a large number of docks have recently been constructed with creosoted yellow pine paving blocks similar to the familiar type of street construction. The blocks present a smooth, hard wearing surface, facilitate trucking, and when laid on a proper foundation will give a floor unequaled in service to any hitherto used.

Large Motor Passenger Vessel

BY A. R. JACKSON

FIG. 1 shows an interesting type of motor-propelled excursion vessel, built at Crescent Park, R. I., for summer service on Narragansett and Mount Hope Bays. This vessel was built by Mr. Charles Loof at his recreation park, near Providence, and was launched into a shallow lagoon connecting with Narragansett Bay.

The hull is constructed of wood, with oak frames and hard pine planking. It is V-bottom with scow ends and has no sheer. The main deck overhangs the hull, the overhang being supported on wooden knees.

The deck plan shows parallel sides with semi-circular ends, the bow and stern being alike. The hull is thoroughly fastened and is braced by diagonal rods running fore and aft on each side.

The principal dimensions are as follows:

Length over all	150 feet
Length on waterline	122 feet
Beam of hull	30 feet
Beam over guards	40 feet
Depth	13 feet
Gross tonnage	557
Passenger capacity	1,200

A large dance hall runs nearly two-thirds of the length of the hull, under the main deck. The engine room is aft of the dance hall, and a refreshment room forward. There is a large cabin on the main deck, with glass sides and comfortable seats.

The upper deck has a pilot house forward, and boats, rafts and other life-saving equipment in accordance with the requirements of the United States Steamboat Inspection Service.

Propulsion is by two 6-cylinder, 4-cycle Standard gasoline (petrol) engines, driving twin screws. The combined horsepower of the engines is 600, and the estimated speed 14 statute miles per hour. The fuel consumption at full speed is 75 gallons per hour.

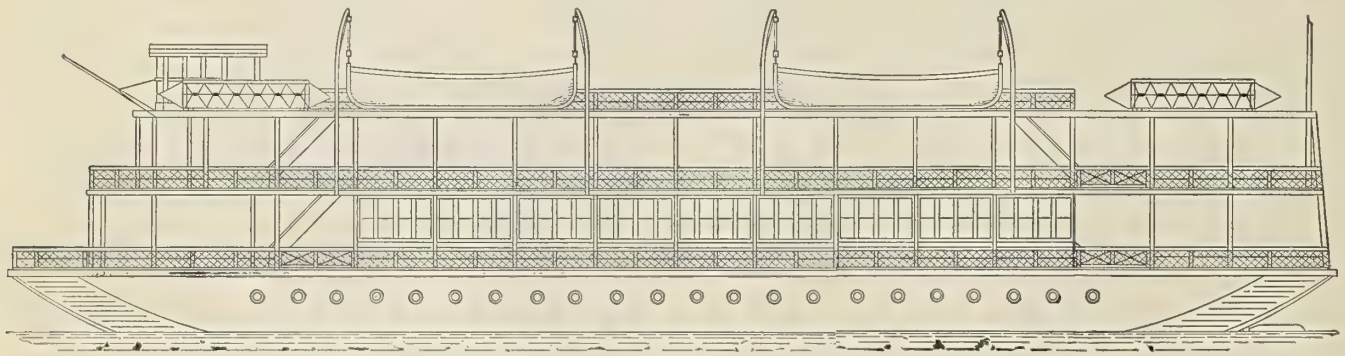


Fig. 1.—150-Foot Motor Excursion Vessel for Service on Narragansett Bay

The engine room is thoroughly fireproofed and ventilated. It contains, besides the main engines, 3 gasolene (petrol) tanks of 400 gallons capacity each, and a three-cylinder gasoline (petrol) engine direct connected to a dynamo for lighting the ship. A large fire and bilge pump is gear driven from this unit, with a disconnecting clutch.

An inclining test conducted by the Steamboat Inspection Service showed that this vessel has ample stability. It is well built and well equipped for the service for which it is designed.

A pair of scissors is on the market, one blade of which is corrugated. For cutting out gaskets and other material they will prove to be a very great time-saver. In heavy material they will cut far better than the usual shears.

Most engineers would have a fit if cast iron nuts were furnished for the valve chest and cylinder covers, yet one end of their studs is always in a cast iron nut. But on that account there are no fits, showing that it makes a mental difference which end of the stud you are thinking about.

A Swedish engineer had a neat way of making a loose stud hold. With a hack saw he cut two slots at right angles across the steam end of the stud the full length of the threaded part, and, after countersinking the end, he dropped a steel ball into the tapped hole of the stud, and screwed the split stud down onto it, which, of course, expanded the end.

Rapid Construction of Large New Shipyard on Pacific Coast Near San Francisco

Plant of Pacific Coast Shipbuilding Company, Covering 247 Acres, Begun January 6—First Ships Now Under Construction

A NOTEWORTHY feat has been performed in the speedy construction of the yard of the Pacific Coast Shipbuilding Company on Suisun Bay, about thirty-five miles northeast of San Francisco. Although the yard, embracing 247 acres, is regarded as the largest in area on the Pacific Coast and one of the largest in the country, and although the first construction work was done January 6, a building schedule has been followed calling for the first actual work on ships in March.

Company Includes Famous Shipbuilders

It is in this company that Henry T. Scott and John T. Scott return to the shipbuilding industry. Henry T. Scott was president of the Union Iron Works, in San Francisco, for about twenty years and for four years he was president of the Moore and Scott Iron Works—now the Moore Iron Works—one of the largest shipyards on the Pacific Coast. John T. Scott was connected with the Union Iron Works for twenty-five years, for the last fourteen of which he was its general superintendent. For eleven years he was vice-president and general manager of the Moore & Scott Company. He is vice-president of the Pacific Coast Shipbuilding Company, of which R. N. Burgess is president.

To Build Ten 9,500-Ton Steamships

The first job of the new company will be the construction of ten 9,500-ton deadweight steamers under government contract. While the $1,500,000 (£307,000) plant will not be completed till May, the work was taken up with a view to having enough equipment in place by March to permit a start being made on the ten vessels, which are to be delivered in twenty-two months.

It is expected that ultimately between 3,000 and 4,000 ship workers will be employed. The plans for the construction of the plant called for the maximum employment of 500 men in building work.

Six Weeks' Progress

The speed with which the building work was advanced by the contractor, the Lindgren Company of San Francisco, is indicated by the fact that in less than six weeks from the first day's work one launching way was 90 percent complete, another 65 percent, a third was ready for the concrete and dredging for the fourth had been finished. Seven launching ways in all have been planned for the yard, four being picked for immediate construction.

Within the same period of less than six weeks the plate shop, 400 feet long and eighty wide, of two stories—400,000 feet of lumber were required for this building alone—was almost complete, with foundations for tools being installed, the date of completion being set at March 1 or earlier. The foundations of other big buildings were in and the superstructures were going up. Sixty-five percent of the grading had been finished, and of the spur track system, more than two miles long, the main line was done, one branch was 80 percent laid, and the other was ready for the ties. Thirty percent of the 700-foot fitting our wharf had been piled and capped. Machinery for the plant was arriving and turbines and boilers for the 9,500-ton steamers had been arranged for. Ninety cars of materials were received and unloaded in this period of less than six weeks.

Location Advantageous

The shipyard is situated on the easternmost branch of the chain of bays beginning with San Francisco Bay. It is near the delta of California's two great rivers, the San Joaquin and the Sacramento, a circumstance of benefit as the fresh river water obviates teredos and barnacles, assuring long life for submerged timbers. The site has a 2,800-foot water frontage, with a 27 foot depth at high tide and ample room for launching large vessels. The property is traversed by three railroad main lines—those of the Southern Pacific, the Atchison, Topeka & Santa Fe and the Oakland, Antioch & Eastern. The power lines of the Pacific Gas and Electric and the Great Western Power companies parallel the railroads, and near by are the pipe lines of the Standard, the Associated and the Shell Oil companies, tapping California's big petroleum fields.

In addition to the 247 acres of the plant site, the company has at hand nearly 2,000 acres of land for supplementary purposes.

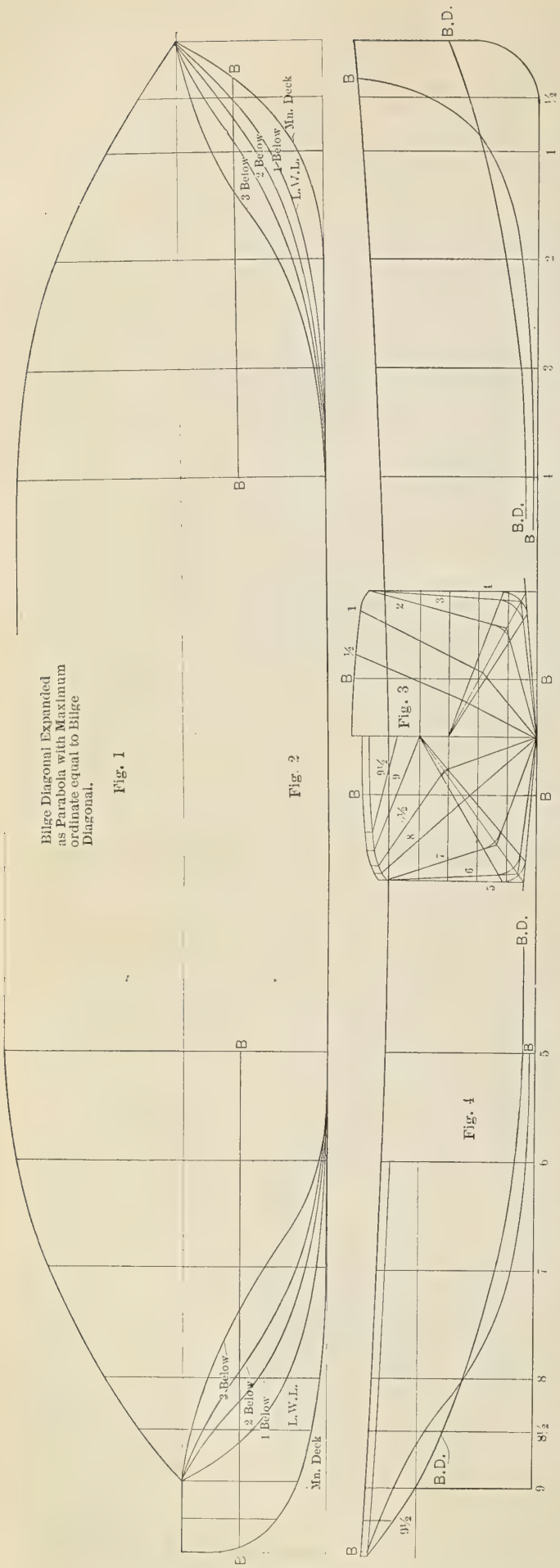
The buildings and ways were designed by Frederick H. Meyer, the architect of many notable works in and about San Francisco. The launching ways are 53 feet wide, with 95 feet between them, and the fitting out wharf is 50 feet wide.

Shops and Equipment

The buildings include a machine shop 120 feet by 400; the power house, 50 by 100; a two-story warehouse, 50 by 150; the planing mill, 50 by 80; an office building, 52 by 110; a hospital, large lockers near the machine shop and the plate shop; a blacksmith shop 50 by 100 and a building of equal size for the tin shop, carpenter shop, electrical shop and acetylene plant. The several tanks include one of 50,000 gallons, with the bay for source, for the sprinkler system.

Aside from the transportation and similar facilities at hand, the site was naturally well adapted to shipbuilding purposes, having physical and climatic characteristics conducive to the formation and continuance of a healthy industrial community. Within a few years several such communities have sprung up along the shores of Suisun Bay, such as Pittsburg, where the annual payroll is more than $2,000,000 (£410,000). Furthermore, the possession of an ample area for all purposes is regarded as another assurance of success, the success of the Newport News shipbuilding plant, with ample land holdings, being one precedent on this point. All the buildings of the Pacific Coast Shipbuilding Company's yard have been designed with the possibility of enlargement in view.

A main bearing cap in medium and small engines is not a binder, but forms part of a hole in which the shaft revolves.



Straight Lined and Fabricated Ships

BY JOHN A. MC ALEER

THE word "fabricated" has been used and misused so much lately that, though one of its meanings is quite well known and probably remains unchanged, some of its other uses might be profitably defined and limited. While this may be a matter that will interest the etymologist more than the naval architect or shipbuilder, I believe that it may be broadly stated that a fabricated ship is one that has been built after the manner of bridges or steel buildings—i. e., that the steel work has been gotten out, fabricated, in one place and the vessel erected and put together in another.

The efficiency of this system has been so demonstrated time out of time that it was only natural to expect that valiant efforts would be made to apply it to shipbuilding in such times as the present. Many that proposed attacking the problem in this way did not thoroughly understand the difficulties in the way of a ship form. To fabricate flat or rectangular work that could all be laid out properly and accurately was one thing, but to attempt it in a gradually changing and somewhat indeterminate ship form was found to be quite another.

Fabrication of Dead Flat Sections Not New

There, of course, was found no difficulty in the so-called dead flat section. Nor was it all new to fabricate this. The Great Lakes yards have for years been practically using this principle in the building of their bulk freighters. The real difficulties were met in attempting to fabricate the ends. The reasons for this were in many cases quite obvious. The work was not flat, neither was it rectangular. The frames had to be heated and during the cooling certain errors crept in. During the later work, to remedy this the personal equation played a large part. Moreover, the transverse curvature of the shell plating varied from frame to frame and many of them had twist as well. The net result has been that the practical shipbuilder has been compelled to confine fabrication to the middle body, and, as has been noted, this is no new departure.

The principle of fabrication is admittedly a good one, but when applied to the ends of a ship the difficulty was purely and simply objective.

Fabrication of Ends of Ship

The next question is naturally this: if fabrication is a sound and economical principle, is there any way that it can be applied to the ends of a ship? The answer to this question is the incentive to this article. If the difficulties in the way of fabrication are mainly objective, then why not alter the ends and make them amenable to the system? The underlying reason for the application of fabrication to the dead flat is that this portion is nearly all straight-lined, and, consequently, this character must be impressed on the ends. If this can be done with no great alteration of the well-known ship form, and, at the same time, producing good, fair and easy lines, the difficulties can be considered solved. This is, therefore, the proposal of this article. Moreover, no claim to originality concerning a straight-lined ship is made. This type has had too many forerunners in the shape of the "Down East" dories and flat bottom sharpies to have any such rash claims made, but in approaching the design of such vessels from a mathematical standpoint this article, it is believed, opens up a new field.

Figs. 1, 2, 3 and 4 show respectively the expanded bilge

diagonal, the half breadth, the sheer draft and the sections of such a proposed ship. To design one, the procedure would be as follows:

First assume a set of sheer heights and a set of deck half breadths. These could be taken from the dimensions of some vessel already built, or, in the case of the half breadths, the deck ends could be taken from the ordinates of an ellipse. As the deck outline will have some effect on the shape of the waterlines, it might be considered advisable to make the load waterline the governing upper curve and let the deck outline be formed from the continuation of the frame lines through these waterline ordinates. In forming the load waterline any of the mathematical methods of drawing such curves can be utilized, but it must be some curve with an equation so that the ordinates at all points can be computed.

Limiting Outlines of Cross Section

The next step is to lay off the limiting outlines of the cross section, as shown in Fig. 3, with the different waterlines, the dead rise line and the bilge diagonals. It would be well to terminate the after bilge diagonal at the intersection of the maximum draft line with the stern post. In the forward section good results have been obtained with the diagonal terminating at the three-fourths draft. However, these are points that could be specially determined from tank trials.

The next point to determine is the length of the ends or, what amounts to the same thing, the length and location of the dead flat section. This having been determined, an assumed expansion of the bilge diagonal must be made, its maximum abscissa being equal to the length of this end and its maximum ordinate to the computed breadth of the bilge diagonal as shown in the sectional drawing, Fig. 5. In expanding this diagonal, the further assumption must be made that its outline is some curve capable of mathematical delineation. Eye curves are not used. It must be some curve with an equation so that its ordinates at all frame points can be computed. In the design shown in the cuts, a parabola has been used, but perhaps even better results might be obtained with trochoids, cycloids or flat ellipses. However, to obtain a mathematical ship, it is quite necessary that the assumed expansion of the bilge diagonal be some mathematical curve. It now remains to be shown how every frame and angular direction in this ship can be computed. In doing this for a ship with curved lines, we first draw in the lines as though the ship were to have square bilges.

Frame Outline Divided Into Three Triangles

In Fig. 5, let the shaded portion represent a frame outline in the run. The outline is first divided into three triangles, as shown by the different shadings. In the lower triangle, *G B A*, we have *A B* equal to the given draft, *G B* the ordinate of the given parabola, used as the expansion of the bilge diagonal, and the constant and given angle γ. We therefore have two sides and the included angle and the triangle is therefore solvable.

The triangle *C F B* is a right triangle and is also solvable, as *C B* is known from the sheer heights and *C F* from the half breadths. We solve this triangle to get the angle α and the side *B F*.

Turning to the middle triangle, we know the sides *B F* and *B G* and the angle β, which is equal to 180 degrees minus the sum of angles α and γ. This triangle can therefore also be solved.

All the line lengths and directions in this frame or any other can be computed in this way. The bevel ordinates can also be computed, the lower ones *x-y* being taken

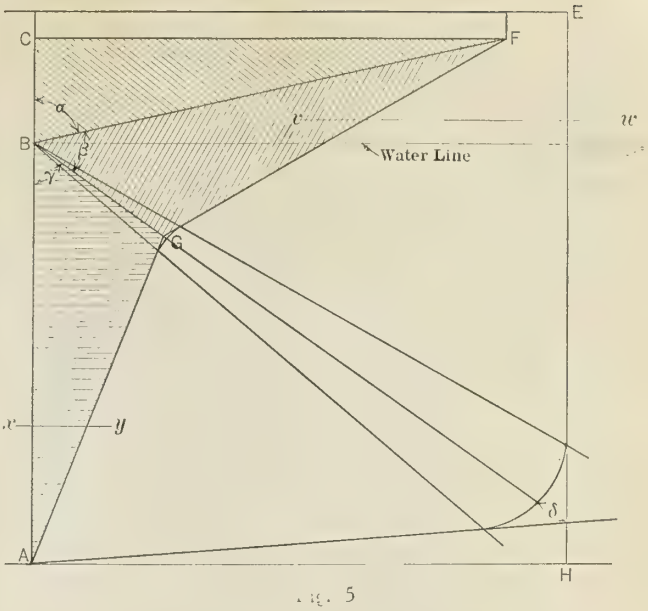


Fig. 5

from the midship line, while the upper ones, *v-w*, will be taken from *E H*. Of course the bevels can be more expeditiously taken from the lines after they have been drawn on the floor.

After the frame lines have been laid down on the floor, the knuckle is rounded in this manner. The bilge radius

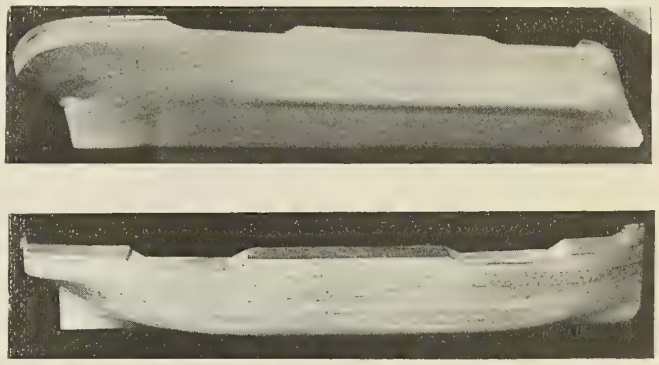


Fig. 6.—Model of the Straight-Lined Hull

for the dead flat section having been determined and drawn in on the floor (it is suggested that this be made as small as possible, not over 18 or 24 inches for large ships), two limiting diagonals are run in, cutting the frame line and the floor at the tangent points of this bilge curve. Where these limiting diagonals cut the frame and floor lines will mark the end of the straight-lined character of these members. The third point on the curved portion of the frame will come on the bilge diagonal proper and its intercept from the sharp knuckle point of its frame will be found by averaging along the number of frames the distance between the bilge curve and the square knuckle in the dead flat. In other words, if the distance δ in Fig. 5 is 20 inches, and it takes 20 frames before we reach a frame that is straight-lined from keel to deck, we will then decrease this value of δ 1 inch per frame. A mold would then be made for the curved portion of each frame.

The frames in such a vessel could all be bent cold in a beam bender, or perhaps locally heated, the bender being first set to the curve of the mold. And it is believed that these frames could also be beveled cold.

In practice, this mathematical computation would be not only tedious but quite unnecessary. The lines would, in

fact, be laid down on the loft floor, and the only necessary computation would be the ordinate of the bilge diagonal, breadths and heights having been, of course, assumed. And if a mathematical curve is assumed for this, a fair ship is assured from the body lines alone.

The body plan having been laid down on the loft floor and all the different lengths and angles computed, to get the shell expansion, the procedure could be as follows. Bearing in mind that all the frames and floors are straight lines, as far as the limiting diagonals, we can easily and cheaply make an exact replica of the ends of the vessel from wood joists and pine sheathing. On this, all the plates can be drawn full size with all the plate landings, butts, etc., and an exact mold, of sheet iron perhaps, can be made for every individual plate giving all the details. Furthermore, a line can be drawn on each plate mold, showing the direction in which each plate must be put through the rollers, when such a process shall be necessary. In this connection it is to be noted that as all the frames are straight-lined, there can be no variation in the transverse curvature, which eliminates one of the toughest problems in plating a vessel's ends. For convenience, so that these end molds would not be too bulky, each end might be made in two parts, one part above the bilge turn and the other below. Then each would appear somewhat like the banked curves of a race track.

The above is only given as a suggestion. It should be quite possible with careful work to lay out all the plating excepting the boss plates, down to the limiting diagonals, on any ordinary flat floor.

Expansion of Bilge Diagonal a Parabola

As has been stated above, in the lines of the ship shown in Figs. 1, 2, 3 and 4 a parabola has been used for the base curve—that is, for the expansion of the bilge diagonal. One reason for the use of this curve in medium speed cargo vessels is the ease with which such curves can be laid out, the ordinate at any frame point, when measured from the half breadth line as a base, varying as the abscissa squared. In other words, the same principle is used as that by which a parabolic arch is laid out.

If other curves are used, such as a trochoid, both for the bilge diagonal and for the load waterline, it might be well within the limits of possibility to develop a hull that would have trochoidal lines throughout. This should be a profitable field for experiment for those schools that possess a model basin.

Crown and Sheer of Deck Eliminated

Turning to other features of standardized ships, it seems quite reasonable to expect that the crown or camber will be eliminated from the deck beams. Another suggestion along this line would be to give the vessel a straight sheer in the dead flat section, and if any curved sheer were considered necessary to satisfy freeboard requirements, to put this in at the ends. This would afford the maximum facility in laying out the central part of the hull, as the work would be entirely rectangular and parallel.

Another feature that should simplify and expedite construction would be to make the floors and tank top parallel and flat and eliminate the centerline vertical keelson. In its place could be substituted an intercostal member and the floors and tank top stiffeners could be carried right through from margin plate to margin plate. This should hasten construction and eliminate quite an amount of expensive work around the center keelson.

There is really no final engineering reason for cutting the floors and then trying to put them together again, and the practice of doing it is simply a relic of the longitudinal system of shipbuilding. Why cut the floors to put them together again, especially when you start with a rolled joint? At best the function of the keelson is nothing more than a distance member and its work can just as well be performed by intercostals. Compensation can readily be made by increasing the section or doubling the keel plate, and perhaps the rider plate. So far as a watertight keelson might be required, the same degree of safety and stability can be obtained by a closer spacing of the continuous watertight floors.

The lines shown in Figs. 1, 2, 3 and 4 are for a vessel 200 feet by 40 feet by 20 feet. The photographs (Fig. 6) are of a model made from these lines, and it is really surprising how pretty a model is obtained from them.

This model was made by Mr. Edward Morris, assistant superintendent of the Chicago Shipbuilding Company, to whom the writer is greatly indebted for his assistance and interest.

New Capacities Attained by Electric Cranes

As a result of the speeding up of shipyards and industrial plants in 1917, there was a greatly increased demand for cranes, electrically operated and controlled. Six of the largest of these cranes were equipped with motors made by the General Electric Company and in most cases with G-E control.

Two cranes were of 225-ton capacity, the total motor rating of each aggregating 420 horsepower; a third crane of the same capacity and motors with a total intermittent rating of 850 horsepower. The two main hoist motors each had a rating of 250 horsepower for continuous and 425 horsepower for intermittent service, giving a hoisting speed for 225 tons of 40 feet per minute and 120 feet per minute for 60 tons.

Due to the high and variable speeds required, the large current demands could not be handled to the best advantage through the usual arrangements of rheostats and contractors, and Ward-Leonard control was, therefore, provided; this being the first application of this system of control on large cranes.

The remaining three cranes were the largest capacity units of this type ever built, being designed for a full load lift with the main hoist hook of 330 tons at 12.6 feet per minute. The power equipment for each crane comprised two 200-horsepower, main-hoist motors, two 105-horsepower auxiliary hoist motors and 80-horsepower and a 30-horsepower motor for main and auxiliary trolley, and two 50-horsepower motors for bridge motion; all these capacities being intermittent ratings.

Two high-speed, alternating-current, hammer-head coal handling gantry cranes, provided with a unique system of dynamic braking, were installed at the La Belle Iron Works plant, at Steubenville, Ohio. Each crane is equipped with a 375-horsepower slip ring induction motor direct coupled to a 40-horsepower, direct-current motor, and hoists a four-ton bucket of coal at 500 feet per minute. The dynamic braking is obtained by combining the small, direct-current motor with the alternating-current motor, so that the direct-current unit serves as an exciter and gives dynamic braking which is comparable with that ordinarily obtained with direct-current motors on this class of work.

This is the first application on any large scale of this system of dynamic braking for cranes, which is more economical in first cost and has a number of practical operating advantages when compared with the method

Hammerhead Traveling Crane Operated by 375-Horsepower General Electric Slip Ring Induction Motor Arranged for Special System of Dynamic Braking

which utilizes a motor-generator set, in addition to an exciter for securing dynamic braking for alternating-current hoist motors. Creeping speeds of 110 feet per minute, lowering, are obtainable with these cranes under ordinary service conditions.

In total, G-E motors and control were installed on more than twice as many applications as in the previous year.

Large Tramp Steamers Recommended for British Inter-Imperial Ship Lines*

LAST fall, Premier Lloyd George appointed a special committee, consisting of ministers of a number of government departments, to inquire into and report upon the best methods and machinery by which to give effect to the policy of Imperial Preference in Trade, as expressed in the following resolution adopted by the Imperial War Conference of 1917:

The time has arrived when all possible encouragement should be given to the development of the Imperial resources, and especially to making the Empire independent of other countries in respect of food supplies, raw materials, and essential industries. With these objects in view, this conference expresses itself in favor of the principle that each part of the Empire, having due regard to the interests of our Allies, shall give specially favorable treatment and facilities to the produce and manufacture of other parts of the Empire.

Among the plans of the Dominions Royal Commission for an elaborate programme for the economic linking up of the Self-Governing Dominions with England and the Colonies, were the following:

"1—The establishment, by government ownership or subsidy, of several great lines of steamships connecting the parts of the Empire, and an inter-Imperial scheme of deep-harbor development to accommodate the ships, 660 feet long, with 38-foot draft, calculated to have the ultimate practical economies of freight transportation which would make tariff discrimination unessential in Imperial Preference.

"2—A system of government rate regulation of shipping and marine insurance on routes between ports of the Empire."

What the commission has gathered for its constructive plan of inter-Imperial shipping is particularly impressive. The master-builders of England's great shipyards have contributed their expert advice to the commission, and in one of its recent reports it is shown in tabular form how the cost per ton of freight transportation can be cut to a fraction of the "tramp" steamer's cost by the use of the immense vessels of steam or motor type that the commission recommends. The future may see these ships running regularly, with seasonable variations from one route to another, on lines stretching out from London to the Far East by way of the Cape of Good Hope, on fast mail and freight lines involving a transfer to rail on the Imperial line from London to Halifax or Quebec, thence by rail to Vancouver, thence by great steamer again to Honolulu, Suva and Sydney or to Hongkong. Or it may be along a third projected all-sea route via London, Liverpool, Halifax, Bermuda, Kingston, Panama, Tahiti, Auckland and Sydney, with alternates to Singapore and Hongkong. These will be the heavy "trunk lines" to the Far East with others through the Suez Canal to India and Hongkong.

Information about the results of what is undoubtedly the most comprehensive survey of the capacities of the world's leading ports by this commission has just reached this country. As a result of this survey, the commission is able to ascertain how much money and how much time will be necessary to carry out the programme of harbor improvement along these Imperial routes which will be needed to enable the great ships to keep up steadily the time schedules that will be a feature of their whole economic scheme. Considering the vastness of the idea, the

* From an article on "The Economic Empire Great Britain Is Welding Together," in *The Americas*, February, 1918.

time and money required seem almost insignificant, as far as the harbor improvements are concerned. And so the commission is now able to go to the British Government, whose Premier is already committed to the plan, with a definite scheme, the biggest problem involved in which is the building of the ships.

Some of the information about the world's port facilities that this commission has gathered is of interest to us. It shows that as a result of our river and harbor expenditures in past years, frequently condemned as extravagant, we have to-day the most comprehensive and uniformly developed system of up-to-date harbors in the world, as far as capacity for accommodating what England is looking forward to as the ships of the future is concerned, awaiting only the mechanical equipment of piers and appurtenances for loading and unloading, which the government here has left to private enterprise. The Panama Canal and our six great harbor systems on the east and west coast can to-day take the greatest ship that floats. We are, therefore, in a position to establish lines of great ships, on our part, if it seems of advantage to do so.

Correlation of England's Harbors

England's ports that lead in the handling of the bulk of highly organized overseas trade are able to take the contemplated big ships now, at high water, and a minimum of expenditure in England is necessary for carrying out the plan of correlation of harbors. In the routes to the East, the Suez Canal, which is now 30 feet deep and will be 33 feet deep as soon as improvements now in progress are completed, will be unable to accommodate the standard ships of 660 feet length and 38 feet draft, but would be used in connection with a subsidiary route to India and the East, with the main ocean track rounding Cape Horn on the way to Australia. Aden, Bombay, Calcutta and Colombo, on the Suez route, are now also limited in capacity for deep-draft ships, but Singapore, Hongkong, Melbourne, Sydney and Hobart will receive the deep-keeled vessels. Capetown and Durban, on the outside route, need only minor development for use by the greatest ships. On the routes to the West, Halifax and Quebec have harbors equal to handling the largest ships. Vancouver and Prince Rupert have also deep harbors. Honolulu can now take ships of only moderate draft, but is being deepened. The harbor of Tahiti is deep. On the Western route proposed *via* the Panama Canal, the Kingston harbor is the only one in which there is not now at least 40 feet of water at ordinary neap tide, and sufficient depth at the docks for the great economic freighter of the future. It is of interest to know that neither Hamburg nor Bremen can accommodate such ships now, but Bremen is supposed to be conducting improvements that will deepen the Weser to 33 feet at low water, and Hamburg is deepening the Elbe to 33 feet depth, low water, with basin accommodations of 36 feet. Antwerp, Havre and Rotterdam are all scheduled for improvement up to the capacity of the contemplated steamships.

As said before, the whole plan hinges on the irresistible economies of big ships, particularly in the case of coal-burning ships. On the economies of these the commission has found:

Unrestricted Draft Necessary

The conclusion that unrestricted draft is necessary for economic transport can be arrived at from first principles. A vessel constructed of a depth sufficient to go to, say, 40 feet draft does not cost so very much more than a vessel of a depth constructed to go to 29 feet draft, whereas the increase in weight of cargo is the difference between the extreme draft of the vessel and the draft the vessel must have in order to float her hull, and machinery, and coal, and stores.

Supposing two ships are constructed, the one of 29 feet draft and the other of 40, and in each case the draft necessary to float hull, machinery, etc., before paying cargo can be put in, is 23 feet. In the one case there is only 6 feet of draft available for paying cargo, whereas in the other case there is 17 feet. The weight of hull for the restricted draft vessel increases much more rapidly than the displacement. The beam cannot be increased in the same ratio as the length, or the stability conditions will be interfered with. Before a great length is reached the deadweight that can be carried no longer increases as the length of vessel increases, but begins to decrease. Farther, the excessive proportion of breadth to draft in the large vessel of restricted draft is bad from the point of view of resistance and therefore the running costs, which depend on the power of the machinery, are considerably increased.

With Unrestricted Draft Cost of Transport Steadily Decreases With Increase of Length

Following out this principle, Sir John Biles supplied various practical and very striking illustrations. He found that if draft were unrestricted the cost of transport steadily decreased with increase of length; thus a vessel 700 feet long, with proportionate draft, could transport goods on a 3,000-mile voyage at a speed of 14 knots, 13 percent cheaper than a smaller vessel of 490 feet in length, while further increase in speed in the larger vessel would be less costly. He also found that increase in length is uneconomical unless accompanied by adequate draft; thus, with draft restricted to 23 feet 3 inches, the cost of transport per ton for a voyage of 3,000 miles by a vessel 700 feet in length would be 50 percent greater than if the same vessel had its full proportionate draft; in fact, increase of length without proportionate increase of draft not only does not diminish cost of transport, but actually increases it.

Recommendations

The plan involves considerable improvement of English harbors, although the survey shows that even now ships of the size desired may enter London, Liverpool and Southampton harbors at the height of the daily tides and be placed in deep berths. It is suggested that the present system of local control of harbors be modified in order to enable the government to carry out the national policy. It is also recommended by the commission that an Imperial Development Board, which it proposes as a means of co-ordinating the efforts of all the British nations, should be given power to regulate ocean rates and quality of service, whatever way it may be finally decided for the governments to establish the inter-Imperial system of ships.

If even a very small steam leak develops in the piping or engine, get after it at once. It is likely to grow worse and always at an inconvenient time.

A wood screw which cannot be started can easily be removed by heating a piece of iron or steel red hot and holding it against the head of the screw for a short time. It expands the metal and so loosens the screw.

What is Happening With the World's Great Merchant Commerce?*

Growth of World's Merchant Marine—Regular Steamship Lines and Tramp Ships—Machinery of Ocean Transportation Wrecked by the War

IN the twenty-five years just preceding the war Europe built up an interlocking, internationally co-operative machinery of trade, industry and transportation, and by commercial diplomacy made the necessary concessions and arrangements in tariffs to permit the machinery to work economically. The whole world, the United States included, took a part in certain phases of this arrangement.

First, there was the machinery of ocean transportation. It was steadily growing to be an international machinery, although the individual nations were strengthening their merchant fleets for exclusively national purposes and taking a more and more advantageous position in trade by doing so. In 1880 England carried 70 percent of the commerce entering and leaving her ports in her own ships, 30 percent of it going in foreign vessels. In 1912, with nearly three times as great a tonnage of shipping going in and out, she carried only 58.2 percent of it and allowed 41.8 percent to come and go in foreign ships. We find Germany, with a great increase in her own shipping and a growth of commerce that caused the tonnage that entered and cleared her harbors to grow from 13,066,412 in 1880 to 49,460,469 in 1911, increased the proportional business of her own shipping in her commerce from 39.1 to 50.3 percent. British ships had carried 38 percent of the German commerce in 1880, and their part decreased to 23 percent. The growing fleets of other nations increased their activities as carriers of German commerce from 22 to 26 percent. The growth in the co-operation of the maritime commercial nations in each other's transportation is shown by the following changes in proportionate tonnage:

	Total Tonnage Entered and Cleared	Own Tonnage Percent	British Tonnage Percent	Other Tonnage Percent
United Kingdom, 1880	58,736,063	70.4		29.6
1912	152,457,045	58.2		41.8
United States, 1880	30,547,026	20.4	51.7	27.9
1912	69,365,104	13.5	52.3	34.2
Germany, 1880	13,066,412	39.1	38.1	22.8
1911	49,460,469	50.3	23.0	26.7
Russia, 1885	10,792,894	8.7	49.7	41.6
1911	27,738,433	10.9	32.1	57.0
Norway, 1880	3,985,477	68.2	11.8	20.0
1911	10,230,279	52.7	9.8	37.5
Sweden, 1880	6,894,155	37.2	13.5	49.3
1911	23,390,647	49.8	5.4	44.8
Denmark, 1880	4,523,643	52.1	11.4	36.5
1911	17,144,432	54.2	5.1	40.7
Holland, 1880	6,844,037	30.9	49.8	19.3
1911	30,847,855	26.6	30.5	42.9
Belgium, 1880	7,116,146	11.6	59.4	29.0
1912	32,672,986	11.4	43.2	45.4
France, 1880	25,032,478	30.0	40.6	29.4
1911	61,366,051	24.0	36.1	39.9
Italy, 1880	9,846,970	34.8	34.3	30.9
1911	51,851,528	27.0	28.7	44.3
Japan, 1900	19,661,602	34.9	38.9	26.2
1912	43,492,604	47.6	30.4	22.0
Argentina, 1880,	2,242,582	11.1	37.8	51.1
Argentina, 1880	2,242,582	11.1	37.8	51.1
1911	25,981,569	43.4	33.5	23.1

The ocean shipping of the world was steadily trending to the establishment of extensive systems of regular lines and of shipping consolidations and conferences, these having great speedy ships on certain routes, with economics of regulated transportation on a large scale; but there were "feeder lines" of smaller boats, and many cargo ships directly owned or chartered that looked out for the carriage of bulky commodities in full-ship quantities by direct voyages, and for the transportation of the seasonal movement of wheat, cotton, hides, etc. There was still the army of "tramp" ships that "found" their cargoes as they went from port to port. Liners and all, however, gave an international service, and the great mercantile ports on the Channel and the North Sea were ports of call. Ships of all nationalities in late years were given access on equal terms and thronged the ports of the great maritime nations of Europe. The tables of statistics showing the tonnage of entrances and clearances in London and the other ports are dry-looking things, but when they are understood and read with some imagination they tell a very interesting story of the great procession of ships, both steam and sail, as they made the round of the harbors and then "stood off" on the long voyages to distant ports, returning by triangular routes, as the stream of shipping, looked at as a whole, carried the heavy tonnage of outward-bound European products to certain parts of the world and then circled about to other producing countries to load the bulky current of the materials Europe imported. It is a picture of the "organization" of ocean shipping, and in it we can see two apparently contradictory developments harmonizing with each other. We can see how the nations that maintained or were building up their merchant shipping wielded a strong influence on the commercial situation proportionate to their marine, and at the same time we can see that all the nations used the ships collectively and in a kind of co-operation. The same intelligent national self-restraint by which intense competition and shrewd co-operation at advantageous points were exercised together shows also in the international use of other institutions of commerce before the war.

During 1917, when the U-boat campaign had its fullest effect in interfering with the organization of ocean shipping and England began to sacrifice trade supremacy to the necessity of concentration upon the war, a decided change in the British system of mercantile re-exportation took place, accentuating a slow development that was already in progress. We are to-day obtaining direct from the sources of supply in British colonies and in countries that formerly sold through London much of the raw materials we formerly obtained in England and in other markets of Europe. In immense tonnages, rubber, tin, hides, wool, etc., have been coming to us direct from the Indies, South Africa, South America, etc., which we formerly bought as re-exports in London, Antwerp, Rotterdam and Hamburg.

When the war ends there will almost inevitably be a disposition of the world's ocean-shipping tonnage very different from what it was in 1913 or what it is now. It has been predicted that the merchant shipping of the United States will be as great in tonnage as that of England. With any such growth of our shipping as is predicted we will surely establish a new system of ocean routes focusing upon our own national harbors. It is proposed that New York shall be made a "free port," which will be an encouragement for our own re-export business, which has already grown from $37,377,791 (£7,650,000) in 1913 to $63,036,795 (£12,900,000) in 1916, and is taking on the

* From *The Americas.*

typical character of a merchandising trade. We are building up typical world-wide merchandising organizations of our own and great London houses are putting branches in New York in anticipation of our sharing at least with England a world-wide organization of ships and commerce.

Germany has lost her organization. The Scandinavian ports are ambitious to locate permanently the Baltic collection and distribution that Hamburg and Bremen used to all but dominate, deferring only to London's commercial power. The British government, in its exercise of war control over trade, has done much to disorganize the London and Liverpool machinery of mercantile commerce. There is great likelihood of a British inter-imperial policy of economic union which will establish either preferential tariffs or attempt to organize government-owned agencies of transportation, etc., favoring inter-empire industry and exchange of products. Everything points to a British intention to take full advantage of the fact that the lion's share of materials needed in modern manufacture are produced, or till now at least have been produced, in the colonies and dependencies.

The war has now made a complete wreck of the machinery, commercial treaties and trade good-will by which the nations in Europe co-operated in furnishing each other with materials, in the processes of manufacture, in selling and transporting. England is on the point of adopting legislation that will shut individuals of "enemy" birth, even naturalized as Englishmen, out of her markets after the war. The little nations and the colonies that did their marketing through European centers have established direct connections. We are getting much of the raw materials we import to-day through the mercantile organization of England but by direct shipping transportation. We have taken over with her whatever is left of British co-operative connections in international commerce. We are expanding our commercial organization and building many ships. What kind of a world organization of commerce will rebuild out of the pieces of the old nobody knows, but it looks very much as if the United States would be in a position either to conduct a pretty capable machine of our own or co-operate with England and our other associate nations in the building of a bigger international machinery than existed before. If we do build up a new co-operation that excludes any other nation, for any reason, it will be a handicap in the rehabilitation of that other nation's own industries, as well as its foreign commerce, not to be lightly considered.

Rain and Spray Excluding Fan for Ship's Port-Holes

TO provide a ventilating apparatus to admit air to the cabins or staterooms of a steamship, but at the same time to exclude rain or spray, W. J. Baldwin, consulting engineer, New York, has designed the machine shown in Fig. 1, consisting of an outer casing made to fit the port holes or deadlight frame and containing an electrically driven fan, to the blades of which a flying band of perforated metal is attached. The fan draws the air through the port-hole, but any rain or spray or heavy particles in the air are carried against the inner side of the perforated metal band, where they are thrown into the casing and discharged through an outlet at the bottom.

The apparatus illustrated, which weighs only about 50 pounds, was used continuously for seven months on the steamship *Munamar,* of the Munson line. When first used the light-shield shown in the illustration was not provided, as this was installed after the outbreak of war, in accordance with war regulations, and is merely for the purpose of darkening the ship at night to aid in eluding submarine attacks.

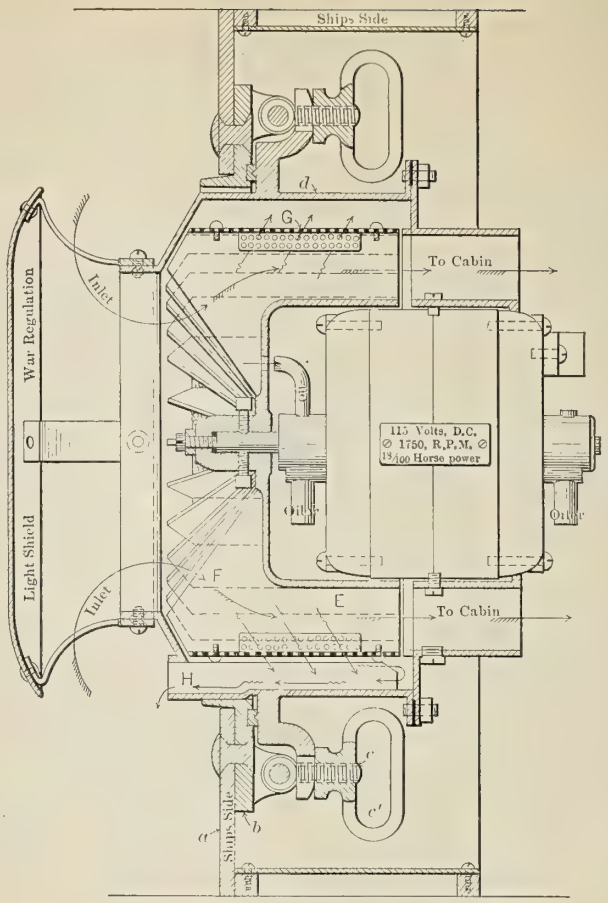
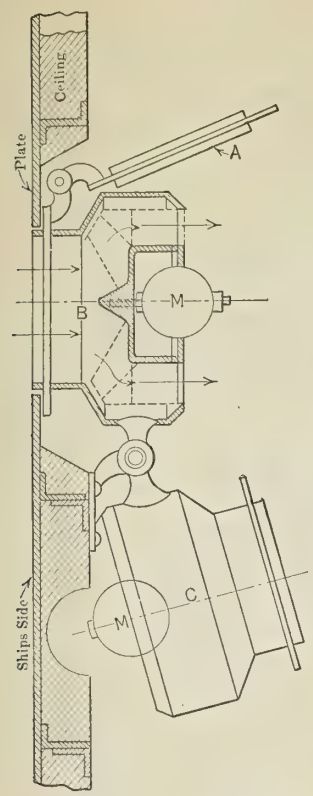


Fig. 1.—Rain and Spray Excluding Fan

The apparatus is hinged to the brass frame on the ordinary deadlight, so that when the glass is swung away and the port opened the machine is swung into place and made tight on a rubber gasket with the same hand screws that are used when the port-hole is ordinarily closed in bad weather. The apparatus has the advantage of being portable and may be used in any deadlight or side light of a stateroom, bathroom or lavatory on the vessel. The one installed on the *Munamar* was never closed, as it was simply moved from the weather side to the lee side of the ship as occasion required.

While conducting experiments to produce a system for removing dust from air by the means of a water spray it was discovered that the water spray actually dried the air that passed through the machine, as well as precipitating the dust. The discovery of this method of drying air economically was a step in the process and led to the design of an apparatus shown in Fig. 3, the object of which is to regulate the hygrometric conditions of the air within an inclosed space. It was found that the action of the machine not only threw out the water fed into it, but was actually taking the excess moisture from the air. This led to the design of an apparatus that would keep the air in a radio room at a fixed condition of humidity, and it was found that it was only necessary to fix the temperature of the water fed to the machine to get any degree of dryness or, for that matter, of dampness in the air. Cold water would produce dryness and warm water would give any degree of humidity by regulating the temperature of the water.

In addition to excluding water, the apparatus prevents



A—DEADLIGHT OPEN.

B—SPRAY, OR RAIN, EXCLUDING FAN IN DEADLIGHT PORT.

C—POSITION OF FAN WHEN NOT IN USE.

Fig. 2.—Rain Excluding Fan Hinged to Frame of Ship's Deadlight

the passage of dock or cargo dust into the ship, and as well kills all insects, throwing them out of the port-hole with the dust.

The electric motor which operates the fan is inclosed in the center of the apparatus, entirely away from the action of the air or water. Seven months' usage of the apparatus on the *Munamar* showed no deterioration either in the apparatus or the motor.

Fig. 3 shows one of the devices designed for the roof of a radio cabinet. In this case the machine has to be systematically supplied with a water spray and with means for carrying away the water. For this purpose the ordinary ship supply can be used, as two ounces of water per minute is ample for the radio cabinet, such as is used on a ship.

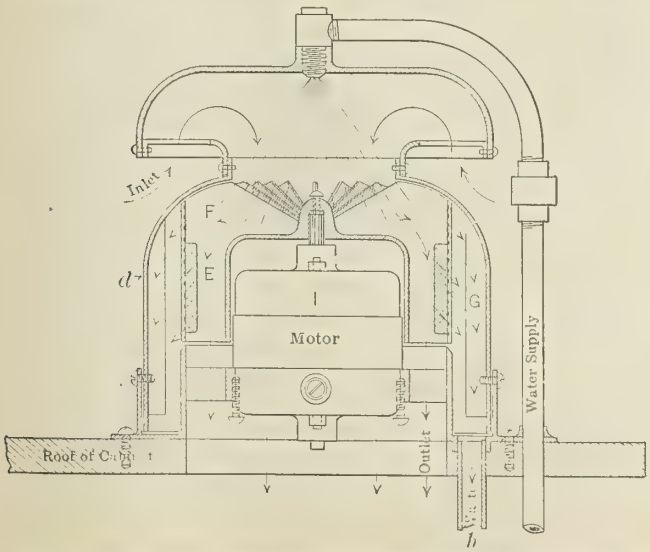


Fig. 3.—Hygrometric Regulator for Radio Cabinet on Board Ship; Capacity, 7,000 Cubic Feet Air per Hour; Power Required, 0.042 Horsepower.

The capacity of the apparatus designed for a port-hole is 36,000 cubic feet of air per hour, and the static air pressure exerted by the fan is from ¾ to ⅞ inch of water. No special wiring is required, and the power required by test is only 0.18 horsepower. The apparatus designed for the radio room will discharge 7,000 cubic feet of air per hour and requires only 0.042 horsepower.

Further Notes on Forced Draft

BY C. H. WILLEY

SINCE completing the series of articles, "Duties of Newly Trained Marine Engineers," the writer has received a communication from the office of James Howden & Company, Ltd., original patentees and manufacturers of the Howden system of forced draft, in which they comment on that part of my third article concerning forced draft. They inform me that when firing, the draft is cut off (as I stated in my article) to prevent "flarebacks," but the ash pit doors are not fitted with any automatic locking device where they supply the furnace fronts.

The furnace door, however, is so arranged that it cannot be opened until the draft is completely cut off. Furthermore, this control (single lever) regulates the entire supply of air to the ash pits.

The sketches show the type of front supplied only through James Howden & Company, Ltd. They have found that very little amount of fan blower control is required under normal circumstances, having learned through experience that the valves on the furnace fronts can be operated to give the best results.

In systems fitted by them, they do not employ a damper in the ash pits. When operating under natural draft, the ash pit door is lifted up, or door opened only.

The following additional notes and instructions for engineers operating the Howden system of forced draft will be found very valuable.

Fire Bars and Furnaces

1. The side bars must be fitted *close to the sides of the furnace* so as to prevent air from passing up at the sides. Asbestos cement, or other suitable material which hardens under heat, should always be kept in the recess made for the purpose. The dead plates must also be air-tight at the sides, and the recess filled with the cement.

2. Care must be taken to have all the fire bars fitted so as to have *no slackness sideways* when working.

3. Thin bars should be used to pack the bars sideways should the last bar of the ordinary thickness to be put in be too thick for the space. The proper allowance for expansion of the bars under heat must be given lengthways.

4. *No air whatever must be allowed to pass through the bridge from the ash pit.* Air must pass from the ash pit through the fire grate only.

Note.—If the tubes are clean when starting, the boilers may run with the retarders continuously for a fortnight, if the fires are properly worked, before requiring to be cleaned.

Firing

The highest evaporative power combined with the highest economy will be obtained with the least labor by carefully attending to the following directions:

1. In firing, the coal must be maintained *nearly level across the furnace, and always a good height at the bridge.*

2. *The coal must not be heaped up in front, as is usual in natural draft boilers, or lie against the cast iron boxes inside the furnace fronts.* When the fire is too high in

front, the air from the cast iron boxes at the sides of the furnace, and from the box on inside of the furnace door, is prevented from striking over the surface of the fuel and effecting its proper combustion. Heaping coal up near the furnace door also destroys the air boxes, and consequently causes the admission of too much air to the furnace without increasing the combustion. All unnecessary use of air in the furnace wastes fuel. The air boxes at the sides of the furnaces, and on the inside of the furnace doors, should keep in order for a year if the firing is properly done.

3. *The fires should never be so thin as to allow air to pass up too freely through the fuel, nor should the fires be too thick to prevent the ignition of the fuel all through.* When a high rate of combustion is being used, the fires should be somewhat heavier. The depth of the fires should also be in proportion to the diameter of the furnaces. The larger the diameter, the deeper the fire. When thick fires are used, the occasional use of the slice becomes advantageous.

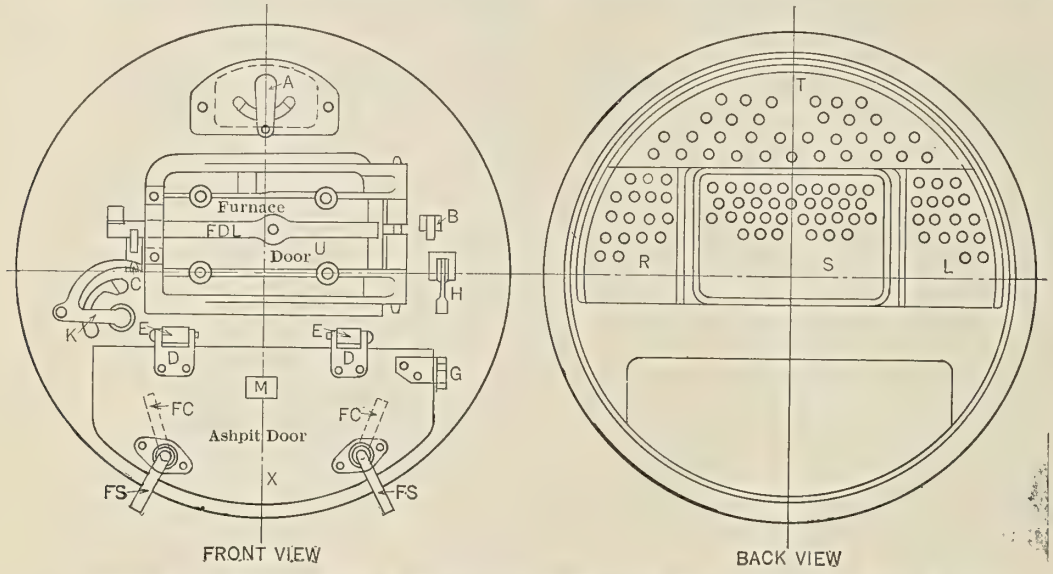
4. As the coal burns more quickly at the sides and the back, *care must be taken to lay the coal well in at the sides in firing,* and to push it back when leveling before firing. *The bars should never be bare at any part of the grate,* as this allows large quantities of air to pass through and cool down the burner.

5. If the fires are burned down irregular in thickness, they should always be leveled up with a light rake before firing. When this is regularly done the surface of the fires will always be kept in good order.

Note.—Heavy smoke with distillation of gas and production of soot, causing deposits of tar and soot on the back tube plates and in the tubes, and which sometimes also causes flaming in the uptake and funnel, is entirely due to the coal being allowed to lie in a dead mass without a sufficient quantity of air being passed through it. This is sometimes caused by the want of sufficient pressure of air in the reservoir. Also by air passing from the ash pit at side bars or elsewhere, or not wholly through the air spaces in fire grate.

Cleaning Fires

1. All the fires must be cleaned from the top and *never pricked from below.* Pricker blades should not be allowed on board. When the light is not seen shining through the bars from the window in ash pit door, the fire is either too thick and requires to be opened up from above by the slice, or clinker has formed on the fire bars, preventing the passage of air through the coals. The heavy slice must then be used and the sharp chisel end made to pass over the top of the fire bars and lift up the clinker from them, turning it on edge. The furnaces may be worked with a good deal of clinker if it is not allowed to lie flat on the bars. The mica window on ash pit door, if kept clean, shows when the fires require slicing. So long as the light shines through the fire bars into the ash pit no slice is required in the furnace. Examination through the window will generally show the part of the grate where the combustion is most retarded.



Mountings for Furnace Fronts in Connection with Howden's Patent System of Forced Draft

A, Top Valve Handle. B, Back Catch. C, Front Catch. D, Hinge Flat. E, Hinge Center. FC, Ashpit Door Handle for Center Front. FS, Ashpit Door Handle for Side Front. G, Catch for Ashpit Door. FDL, Furnace Door Latch. H, Hanger for Ashpit Door. K, Slide Valve Handle. L, Left Hand Baffle Plate (or Air Box). M, Mica Plate. R, Right Hand Baffle Plate (or Air Box). S, Door Baffle plate (or Air Box). T, Top Baffle Plate (or Air Box). U, Furnace Door. X, Ashpit Door.

Working Air Valves

1. In working the air valves, it is understood that the *air pressure in the main discharge pipe from the fan is not under two inches,* and it may rise to four inches if the quality of coals or rate of combustion require it. If the pressure in the air pipe is too much for the requirements in the furnace with both ash pit valves opened, then these valves should be partly shut.

2. The top air valve, which is for the purpose of consuming the gases and reducing smoke, should not be shut when firing or even in cleaning fires. It should be set by the engineer to suit the kind of coal being used when starting, and never moved during the voyage unless to prevent steam blowing off when the engines are stopped, and even then not entirely closed. With the best coal one-third to one-half open is sufficient, but a greater opening is required for highly bituminous smoky coal. When this valve is open more than necessary it tends to reduce economy.

3. When steam is rising faster than is wanted, the ash pit valves should be partly shut.

4. When working natural draft *shut ash pit valves, open ash pit door, and keep the upper valve full open.*

Note.—Never open the furnace or smokebox doors to

keep down steam, as the combustion is perfectly controlled by the air valves.

Be careful when working to have the furnace and ash pit doors perfectly closed.

Working a Number of Boilers Together

To maintain a constant and full supply of steam when working a number of boilers together, each fireman should work the furnaces under his care as if there were no others in the ship.

As each fireman will use different quantities of coal, and will give the fires different treatment, a number of men firing merely by rotation will tend to bring the fires into an irregular and unfavorable condition.

The cleaning of fires should not, therefore, always be left to be done at a given hour. Some coals very soon run a clinker over the bars and prevent combustion from below, which may reduce the effect of the furnace from one-half to two-thirds. Whenever the mica windows (which should always be kept clean) do not show the light shining in the ash pit, the slice must be used to lift the clinker from the bars.

It is not always necessary to remove all the clinker. If it is turned on edge it will not hinder combustion, and it can be removed at convenience. The frequent use of the slice to clear the fire bars from clinker and partial cleaning of fires whenever required, will always keep the fires in best condition and make the thorough cleaning of the fires at the usual intervals a much lighter operation, which should occupy a few minutes' time.

Cleaning fires with this forced draft should in no case cause any drop in steam pressure. Though one fire in each boiler was being cleaned simultaneously, the steam pressure should be fully maintained.

This is easily accomplished by observing the simple rule that no fireman begins to clean a fire until the other fires under his care are put in good condition, with a proper charge of coal on each and full air pressure below bars. Following this course in some steamers with single boilers having three furnaces only, the engines are maintained at full speed and the safety valves made to blow off while cleaning fires. An equal effect should be aimed at also in high-powered steamers with many boilers.

Treatment of fires, whether in firing, slicing, dressing or cleaning, should be done rapidly. Far too much time is generally taken sorting fires.

Suitable tools for each fireman should always be lying at his hand so as to prevent loss of time in completing his operations.

Following these instructions, every fire should always be in good order and steam plentiful.

These instructions were received by the writer from the manufacturer of the Howden System.

Furnace Design Can Be Improved

THE Bureau of Mines, Department of the Interior, after several years of experiments in fuel combustion in a special furnace, makes the announcement that, from the results, it is possible to design a furnace with considerably more assurance as to its capabilities than has heretofore been possible.

Starting with the analysis of the coal to be used and the rate at which it is to be burned, the furnace dimensions in feet and inches can be designed with a reasonable assurance of obtaining a desired degree of completeness of combustion.

The bureau has just made a report on this subject, Bulletin 135, "Combustion of Coal and Design of Furnaces," by Henry Kreisinger, C. E. Augustine and F. K. Ovitz. The publication marks a period in work approved in 1906 by a National Advisory Board appointed by the President to advise the Government concerning fuels. The bureau proposed to conduct such experiments as would make it possible to design fuel-burning furnaces on a rational basis rather than by the cut-and-try methods of the past. The process carried on in the combustion space is influenced by many factors, the most important of which are the volume and shape of the combustion space; the kind of coal used, especially the character and amount of volatile matter it contains; the rate of firing; the quantity of air supplied over the fuel bed; the rate of mixing the air with the combustible rising from the fuel bed; the rate of heating the coal; and the temperature in the combustion space.

The qualitative effects on the rate and completeness of combustion of many of these factors have been known for a long time; but the quantitative data, presented in definite units, of seconds, pounds, feet, or percentages, have been lacking. To obtain such definite information, a study of combustion in the space beyond the fuel bed was undertaken, and the results of extensive tests are given in this bulletin. About 100 elaborate tests were conducted in a special furnace using three kinds of coal—Pocahontas, Pittsburgh, and Illinois—and at rates of combustion covering the full range found in practice. These are believed to be the most extensive tests of the kind ever undertaken.

While the bulletin is especially for those interested in the design or reconstruction of fuel-burning furnaces, it contains much of interest to the general engineer interested in fuel problems. Some of the statements sure to arrest the attention of the interested engineer are as follows:

The size of the combustion space required appears to be directly proportional to the percentage of oxygen in the moisture-free and ash-free coal.

The percentage of excess air that gives the best results varies with the size of the furnace and the kind of fuel. This fact explains why in one plant the highest efficiency may be obtained with 14 percent of CO_2 in the gases, and in another plant with only 10 percent of CO_2.

There is a definite relation for each coal between the excess air supply and the percentage of CO_2 in the furnace gases.

Soot is formed at the surface of the fuel bed by heating the hydrocarbons in absence of air. It is not formed by the hydrocarbon gases striking the cooling surfaces of the boiler. As a matter of fact, only a very small trace of the hydrocarbon gases ever reach the surface of the boiler. Hydrocarbons that do so are prevented from decomposition by the cooling effect of the contact. The cooling surfaces do not cause the formation of soot; they merely collect soot and prevent its combustion.

It seems that most mechanical stokers are smokeless, not because they burn the smoke, but because they burn the coal in such a way that very little soot or smoke is produced. Hand-fired furnaces are smoky because soot is produced in or near the fuel bed, and cannot be burned in the limited combustion space of the furnace.

Copies of this publication may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

The design of metallic packing is important, yet the material of which it is made is of equal moment.

Why Is Tonnage?

Mac, the Veteran Ship Draftsman, Explains the Various Systems of Measuring Vessel Tonnage

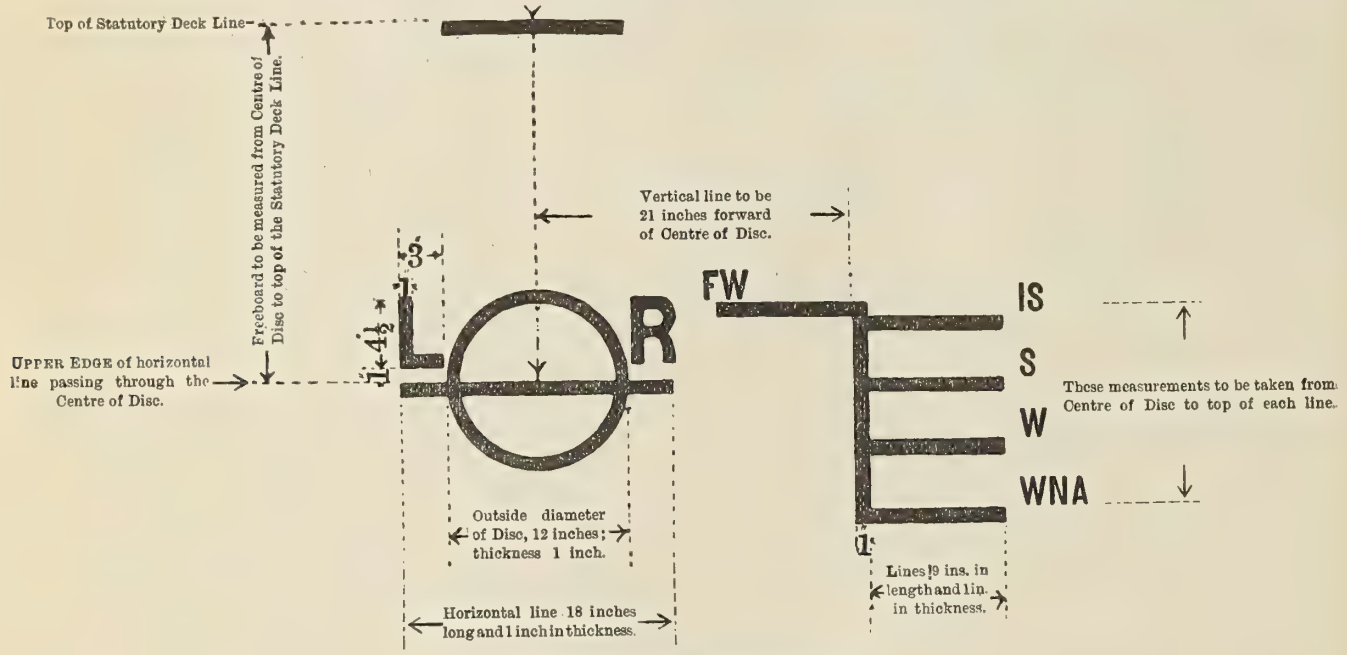
"MR. MAC, we were down on the dock this noontime taking a look at that tank that is going away next week. Somebody wanted to know what it costs to dock a ship like this. The dockmaster told us that for a ship of this size it costs twenty-four cents (1/0) per ton for the first twenty-four hours, and eighteen cents (0/9) per ton each twenty-four hours afterwards. There is no charge on Sundays and holidays, if no work is done on the ship. Then somebody wanted to know how many tons? The dockmaster did not know. I have looked it up, but am about as far away as I was before. She displaces 15,000 tons, has a deadweight carrying capacity of 10,000 tons, has a gross tonnage of 7,000 and a net tonnage of 4,500. Why is tonnage, anyway?"

"Well," replied Mac, "the charges on this dock are, as I remember, based on gross tonnage. This would make a charge of $1,680 (£344) the first day and $1,260 (£258) afterwards. Net tonnage could have been used as a basis of charging, as in the case of canal tolls, but gross tons seem to be the style around here. With net tonnage the rate per ton would be higher and maybe the reason can be found in this, that the use of gross tons gives a low rate per ton and it sounds cheap. Some real estater is able to prove that it is cheaper to dock a ship here than somewhere else where net tonnage may be used as a basis. Of course, it costs the same in either case.

"Displacement and deadweight carrying capacity are measured in long tons of 2,240 pounds; 2,000 pounds is a short ton, and 2,204 pounds, or the weight of a cubic meter of fresh water, is a metric ton.

"Gross and net tonnage are measured in tons of one hundred cubic feet of enclosed space in the ship. There are 44 cubic feet in a ton of coal, 40 cubic feet to the ton of package freight, and water occupies 35 cubic feet to the ton, so that this ton of 100 cubic feet needs explanation.

"In England in 1854, when the matter of tonnage was under discussion, it was found that the registered tonnage of the entire British merchant marine was 3,700,000 tons, according to the then existing measurement rules. The actual cubic contents was estimated at the same time to be 363,400,000 cubic feet. A ratio of 1 to 98. With the idea of keeping the registered tonnage about the same as it had been and at the same time simplify calculations, the gross ton was officially made 100 cubic feet of enclosed space. The United States adopted this measurement standard in 1864, and now it is universally used.


Top of Statutory Deck Line
Freeboard to be measured from Centre of Disc to top of the Statutory Deck Line.
Vertical line to be 21 inches forward of Centre of Disc.
UPPER EDGE of horizontal line passing through the Centre of Disc.
41/2
3
L
R
FW
IS
S
W
WNA
These measurements to be taken from Centre of Disc to top of each line.
Outside diameter of Disc, 12 inches; thickness 1 inch.
Horizontal line 18 inches long and 1 inch in thickness.
Lines 9 ins. in length and 1in. in thickness.

Lloyd's Freeboard Marking for Steamers

"Gross tonnage, then, is a measure of the enclosed space in the ship. Net tonnage is gross tonnage after certain deductions have been made of spaces which are not permanently enclosed or cannot be used for carrying cargo.

"The measurement of gross tonnage is described in detail for all classes of ships in a United States Department of Commerce publication called 'Measurement of Vessels.' These rules are unhandy and I always feel that I have more than earned my money any time I have to refer to them. They are tough. Of course these rules are intended for Government surveyors or inspectors, but in the case of a steel ship the drawing office usually gets up a tonnage drawing showing the principal dimensions of the ship and sections, so that the gross tonnage can be calculated. We generally do the calculating also.

"Part of the enclosed spaces on a ship are supposed not to be used for carrying cargo, and are therefore deducted from the total or gross tonnage. The engine space, living quarters, bosuns' stores, etc., are such spaces. Steward's stores, refrigerating spaces, etc., are not deducted because they can be used for stowage of cargo.

"Most charges, such as canal tolls, pilotage, towing charges, etc., are based on net registered tonnage, so that it is not surprising that all the slick ones, the fellows who

were bitten in the ear by a fox when they were very young, are trying to beat net registered tonnage. The more space that is exempted or deducted, the smaller this net tonnage and the less the taxes or charges against the operation of the ship. Spaces are exempted for purposes for which they are not used. Rooms for non-resident doctors, pursers and freight clerks may be used as storerooms.

Tonnage of 'Tween Decks Space

"The most notable exemption and evasion of the spirit of the law is that of the 'tween decks space that is supposed to be opened to the weather by tonnage wells, tonnage openings, freeing ports and scuppers. These openings can be covered by planks and tarpaulins and the freeing ports and scuppers plugged. The space is made as dry and secure as any unexempted space.

"As I remember it, the law says that any permanent closed-in space on the upper deck and available for cargo shall be added to the tonnage. The evasion of this rule hinges on the interpretation of the meaning of the words "permanent closed-in space." Fitting of such tonnage openings became a regular practice until exemption was refused for a 'tween decks space on a Scotch-built steamer named the *Bear*. An English decision in the House of Lords sustained the owners of the *Bear* in their claim for exemption, and to-day similar spaces are regularly exempted. 'Measurement of Vessels' gives rules, etc., showing in detail the proportions, etc., for the tonnage well and tonnage openings for securing this exemption.

"A plan showing these exempted spaces is made for the convenience of the measurers who certify the spaces to be exempted, and a list of labels or signs is gotten out for the purchasing department to buy uptown those black and white enameled signs you see over the doors.

Deadweight Scale

"On a capacity plan made for the use of the owner of the ship is usually shown what is called a deadweight scale—a vertical draft scale alongside of a displacement scale. The zero of the deadweight scale is opposite the light draft of the ship. The upper limit is the full load draft, and the corresponding carrying capacity in long tons. This, of course, amounts to the displacement at full load minus the displacement at light load. Sometimes three scales are shown. The draft is in the middle, deadweight carrying capacity on one side and tons per inch on the other.

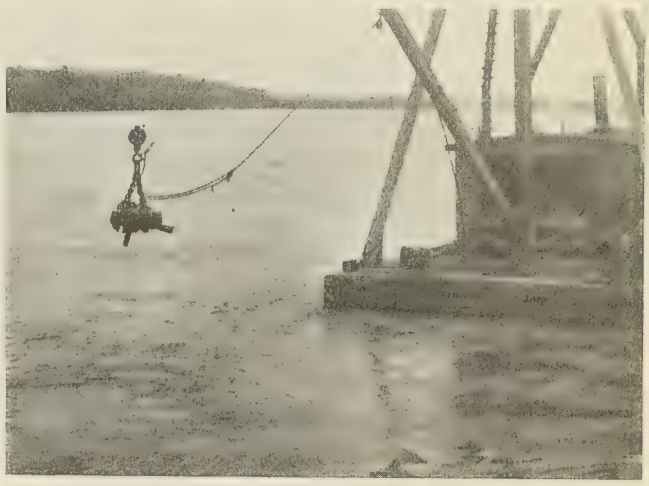
"The full draft is determined by what is known as the freeboard marking for steamers or sailing ships, if the ship is built to Lloyds. Our American Bureau so far has no such marking. A committee of Lloyd's Register assigns this marking to British ships. It is the waterline mark you have seen on the shell of a ship amidships. It is fully described in the back of Lloyd's rules and regulations. When the ship has been surveyed Lloyds sends out a letter having a marking of this kind stamped on the reverse side and properly filled in so that the marking can be cut in and painted white on the shell of the ship. The marking for a steamer is shown in Fig. 1.

"The *L R* stands for Lloyd's Register. *F. W.* means fresh water; *I. S.*, inland sea; *S.*, summer; *W.*, winter, and *W. N. A.*, winter in the North Atlantic Ocean. The idea is that a ship should have more freeboard in rough weather and that she will draw more in fresh than in salt water.

"There was a ship in port the other day that brought 12,000 tons of cocoanut oil and several tons of rice and only registers about 5,000 net tons. Lumber schooners that carry 1,500,000 board feet of lumber often register only 1,250 gross and 700 net tons. A large part of their cargo is not enclosed, hence the great difference."

Sunken Cargo of Pig-Iron Recovered by Lifting Magnet

THE Arrow Transportation Company, operating a line of barges on several of the southern rivers, lost one of its barges in the Tennessee River near Paducah last March. This barge, loaded with about 420 tons of sand-cast pig-iron, collided with the pier in the river, and the barge began listing, dropping its load gradually and, therefore, strewing the pig-iron along the bed of the river for a distance of about 100 feet or more.



C-H 43-Inch Magnet Bringing Up a Load of Pig Iron from the River Bottom

The loss represented about $10,000 (£2,050), and the insurance company paid over this amount to the Transportation Company. The insurance company later made arrangements to recover what they could of the cargo by means of a barge and a C-H lifting magnet, purchased from The Cutler-Hammer Manufacturing Company, of Milwaukee. By letting the magnet down to the bed and dragging it along in the vicinity in which the material had sunk, over 90 percent, or approximately 400 of the 420 tons, was recovered.

The cargo was not only saved, but, because of the rising cost of pig-iron, it was sold for $16,000 (£3,280), while the total cost of recovering, including the rental of barges and the purchase of a magnet, amounted only to $4,000 (£820), which gave the insurance company approximately $2,000 (£410), plus a lifting magnet, which has since been put to use in salvaging other lost cargoes. The magnet used was 43 inches in diameter, and of the standard C-H type, which is waterproof.

A little more care in cutting out gaskets from sheet packing will make a big saving in that commodity. It is time that more attention was paid to this important, if minor, detail.

When the engineer's requisitions are not honored in full it is time to get a new chief or a new man in the supply department. Trust a man or fire him.

Most men, when counting revolutions, count one too many by counting "one" when the cross-head starts down instead of when it just comes up to the top of the stroke. Begin the timing when the cross-head starts down and the counting when it first comes up.

Letters from Marine Engineers

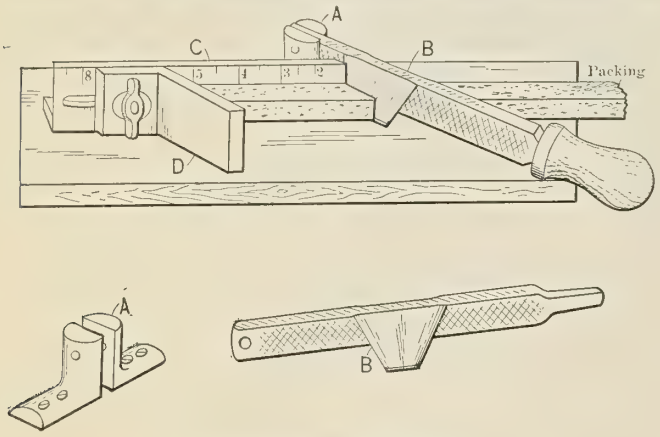
Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Rod Packing Cutter

A very useful device for cutting rod packings was devised and used by the writer, and it may be found worth while to others. There are so many piston and valve rods and stems, slip joints, etc., which are always calling for packing, and the use of this device will save a lot of packing and labor in cutting the rings to proper length with quickness and ease.

Like many other useful devices, it is a home-made product, and can be made quite easily by any engineer or



Home-Made Packing Cutter

mechanic from materials to be found on board ship, an old file, a piece of angle iron, a bit of flat stock, etc. The sketch clearly shows the tool.

The cutter is made from a long, flat file, drawing down the knife section as shown in *B*. This cutter is held in the guide posts *A*, which are secured to the board at a 45-degree angle from the packing guide *C*, which is made from a piece of angle iron. A longitudinal slot is cut for the adjustment of the length gage *D*. This is made from a small piece of flat steel bent to 45 degrees. The scale on the angle iron is graduated to cut packings to fit rod diameters from one to eight inches. The leverage of the cutter does the trick excellently, and the writer would not be without the cutter now. ENGINEER.

Improvised Dutchman for Shaft Coupling

During a high-speed, force-draft run one of the blower fan shafts fractured close to the outboard coupling, as indicated in Fig. 1.

The shaft and coupling were removed and the broken stub end forced out of the coupling. The shaft was put in the ship's lathe, squared up and centered, and a new fit made for the coupling, as shown at *A*.

This shortened the length of the shaft 3 inches. The key way was cut and then the coupling was forced on and keyed to the new machined end. Next, six special long bolts with three nuts on each were made and used, as shown in Fig. 2. The shaft was put in place and the bolts put in and adjusted to give 3 inches distance between the inside faces of the couplings, using a 3-inch distance piece as a caliper.

Next the complete coupling was formed into a mold by a band of sheet iron and some putty, leaving a pouring gate and a riser at the top for excess metal. Then the space between the faces of the couplings was filled with molten babbitt covering the bolts and filling, as shown in Fig. 3. This gave a very good Dutchman or distance piece and a quick repair.

It should be said that there was not a piece of stock of right dimensions on board to make a new shaft or solid distance piece. We thought at first of using pieces of pipe slipped over the bolts in between the faces, but

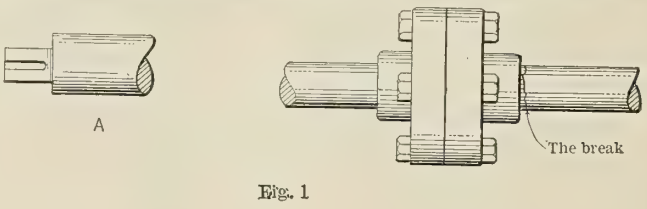


Fig. 1

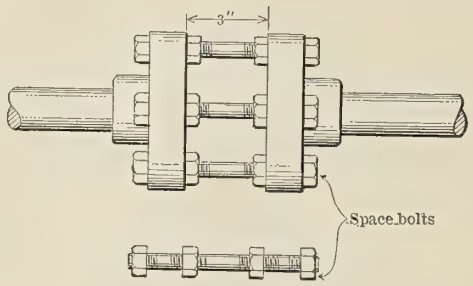


Fig. 2

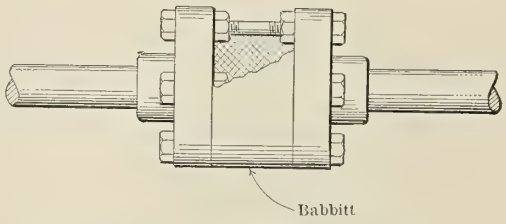


Fig. 3

Temporary Repair to Blower Fan Shaft

abandoned that scheme when we thought of the use of long, solid bolts.

The repair was made at sea and we completed it four days out, and had no further trouble, as it stood up to full speed.

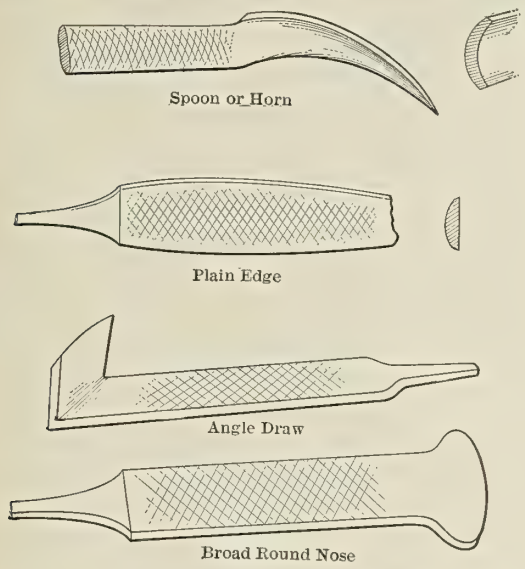
If any of the readers of MARINE ENGINEERING have the misfortune to meet with a broken shaft of small dimensions in a like way, the writer recommends giving this stunt a trial. Perhaps I should have mentioned that the outer circumference of the babbitt was peened dense with a ball peen hammer to fill solid, due to shrinkage in cooling. The

excess metal poured into the gate and riser of course aided the feeding for shrinkage, and but little peening was needed to make it absolutely tight.

Concord, N. H. C. H. Willey.

Scrapers

Don't throw away your old files. Use them for scrapers, as shown in the sketches. Every day steel is becoming scarcer, especially tool steel. You can do your bit to conserve the steel supply by making some of your tools from discarded, worn-out files, such as scribers, punches and



Scrapers Made from Old Files

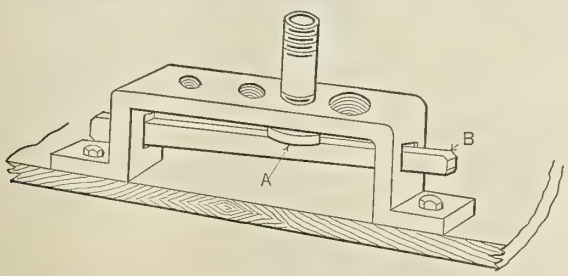
drifts, knives, chisels, packing tools, cotter pin extractors, and numerous other tools.

In working the files under the hammer, be sure to do so only when the heat is red. The moment the file cools to dark or gray there is danger of fracture if you continue to forge it. Conservation.

Stud or Nipple Vise

All of us at some time or other have tried to improvise a means of holding a pipe nipple while we run down the threads, such as when making close nipples.

The device shown in the accompanying sketch has been used with a great deal of success and convenience, and may be found equally helpful to some of the other readers. It is easily constructed from a piece of ½- by 4-inch flat stock. The holes for nipples or studs are drilled and tapped through the top as shown. A washer or disk, *A*, is used between the bottom edge of the nipple and the edge of the wedge *B*. By driving in the wedge it forces the washer *A* against the lower edge of the nipple and binds

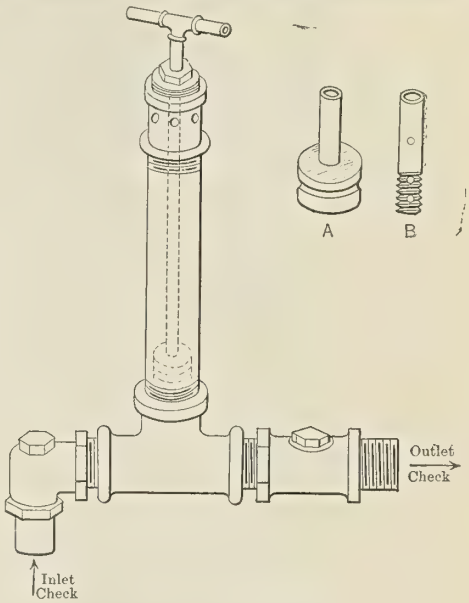


Construction of Vise for Holding Pipe Nipples While They Are Threaded

it securely. The sketch quite clearly shows its principle and construction. Machinist.

Handy Pump

No more useful article of equipment in the engineer department of a ship can be found than a hand pump of the type shown in the sketch. When the crank pits accumulate water or oil, when the thrust block oil well needs to be emptied, when the bilge pump strainer well needs to be dried and cleaned (like when you are going to red lead



Home-Made Hand Pump

the bilges, etc.), and numberless other places and tasks, this pump will be a labor and patience saver.

It can be made in almost any reasonable size from materials found on any ship, namely, some pipe fittings and a little babbitt metal. The plunger is made of babbitt metal, cast on the lower end of the pipe plunger rod, as shown in *A* and *B*. The end is threaded, and two small holes drilled to anchor the babbitt. The mold used to cast the plunger can easily be made of plaster of paris, or by chucking out a hard block of wood.

A water groove is best for this kind of plunger, which should be at least two inches deep. The babbitt is easily scraped to a nice fit in the pipe cylinder. When worn, the renewal is but a small task of re-casting. Drill small air outlets at the top and one or two in the rod, as indicated.

W.

The Removal of Propellers

One of the most troublesome of dry dock problems is the removal of the screw propeller from the tail shaft for examination and the relining of the stern tube. A case which several years ago came under the writer's notice was that of a bent tail shaft which would not draw through the stern tube. It is some time ago, because the remedy applied was truly herculanean.

A gang was set to work with ratchet braces drilling radial holes, some twenty 1¼-inch holes were drilled by hand round the shaft and each brace being kept continuously employed by reliefs. A suspended battering ram was then used to break off the projecting end of the shaft, while the tail shaft remained many a long day the object of interest to the visitor on the dock side.

Had the modern cutting torch been available it would have spared much expense, as something under an hour would have obviated the thirty-six hours' sheer toil required.

The president of the Institute of the Marine Engineers (London), Captain Richard Green, of Fletcher, Son & Fearnall, a well-known firm of ship repairers, told the following story in his recent presidential address: "One of the constant sources of trouble in the early days was the fit of propellers on the tail shaft, and most of us can remember the tussles that one had in getting a propeller started.

"One case always remains in my memory, on which we wrought three days and nights without being able to get a move out of the propeller. All the blades had been removed but every effort failed. Meanwhile, with continual heating, both shaft and boss had become very hot, also the superintendent engineer on the matter of delay.

"As a last desperate resort a ¾-inch hole was bored through the shell of the boss under the seat of one of the blades and a length of ordinary gas pipe coupled up with the water main. The water was turned on and we awaited with expectation and some anxiety the result. We had not long to wait; for, with a report that shook the whole ship, the sudden contraction of the tail shaft shot the propeller hard against the stern post.

"The scared look on the face of the old superintendent as he rushed on deck from the cabin brought a hearty laugh, which relieved the tension of tired and irritated men.

"No damage resulted either to boss or tail shaft, which were refitted after examination and cleaning."

The primitive wedging with horseshoe collars behind the wheel and internal strutting to relieve the crank webs is a labor of great magnitude and the process does not always result in success, besides being clumsy. Failing this, heating the boss for release by expansion, unless there is some provision to release the contents of the vacant space inside the boss, is dangerous. If there be moisture present in very small quantity, the boss can be ruptured by the generation of steam, and accidents due to this cause are not unknown.

Any attempt to pull off the boss by mechanical means like screw or bolts and a strong back by the same principle that taper fits are dismantled in the usual machine shops is virtually impossible. The stern post and rudder, the limited propeller aperture, the fine character of the taper and its exposure to sea water, the limited area of the boss itself, all impede the application of such means.

There does exist a simple and positive device for the removal of propellers, taking only a few minutes in actual operation; it surprised the writer recently to find that the old style procedure was still in operation in some quarters and that the man in charge had never heard of the device. Thinking, therefore, that it is in the interest of marine engineers in general to give the device the publicity it deserves, the writer desires to draw attention to the Youngs' propeller starter. I hasten to add that I have no connection with the manufacturer, nor am I interested in any way other than the merit of the device.

The makers are Youngs of Birmingham, makers of lifting tackle and hydraulic jacks and other appliances. It consists essentially in a segmental cast steel frame in separate sections, each of which has a segmental hydraulic ram. The sections assemble into circular form behind the propeller boss, and by the use of suitable packing pieces 2, 3 or 4 segments can be operated. Each segment is interconnected by copper loop tubes which joint by unions, that the movement and pressure of the rams shall be simultaneous. A hydraulic test pump or boiler prover completes the outfit and two sizes are made, 300 tons and 450 tons.

The internal shaft is strutted in the usual manner, the device applied behind the boss and a few minutes' pumping serves to give separation after slacking back the main nut. So far as is known, no propeller has ever refused the gentle persuasion brought to bear and the prices charged for the device are by no means inordinate.

It is certain that the device is in use in literally hundreds of places, but, like many another first-class device, there are always a proportion of people to whom it would be a godsend who are ignorant of its merits.

A. L. Haas.

Temporary Pipe Patches

Marine engineers have to contend with a great many leaky pipes, and when a section of pipe springs a leak it is not always convenient at the time to cut out the bad section and replace with a new piece. Then, again, it may not be most economical, for the leak may be so located that to take out the bad piece would require uncoupling many sections of pipe to be able to get to it. On threaded pipe this works to its detriment, for seldom do the pipe joints re-make tightly without extra forcing into their couplings, etc. Again, when a leak does occur it generally is necessary to make temporary repairs to keep things going, and to this end the collection of temporary pipe patches taken from the writer's note book may aid some to make repairs easily.

With the great quantity of salt water service piping found on board ship there is bound to be ample requirements for one or more of these patches, for one can never tell when a section will be eaten through by corrosion. The writer has made it a point to make up several emergency patches for various sizes of piping, and those who

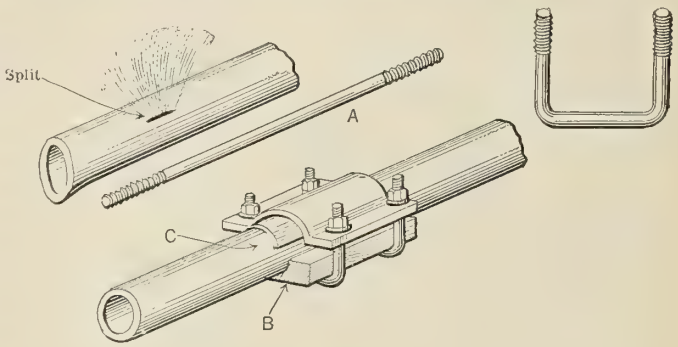


Fig. 1

are serving on board of an old vessel know fully the value of preparedness along these lines.

The U-bolt patch in Fig. 1 is very serviceable and easy to make. It consists of two lengths of round iron stock, shown at *A*. These are threaded at each end and formed into U-shape to comply with the required size. A block of hard wood is cut to V-shape, as at *B*, and a half-round metal patch is formed to the circumference of the pipe. A piece of rubber gasket is used under this at *C*.

The coupling patch shown in Fig. 2 is one that can be quickly made, when the troublesome leak is on small size pipe lines. One can generally find in the scrap pile or in the stores on board a piece of the same size pipe, or perhaps a larger size. By cutting a couple of pieces of this off and splitting as shown in Fig. 2 at *A*, then bending the ears back as indicated in the dotted lines and drilling a couple of bolt holes in the ears, the patch is then ready.

Wrap a piece of gasket around the leaky pipe and then bolt on the patch.

For small leaks on low pressure pipes the simple band clamp shown in Fig. 3 is easily and quickly made from a piece of band iron. This must be formed hot on the pipe and cooled, the bolt holes being first drilled.

Figs. 4-5 show what is perhaps a unique temporary

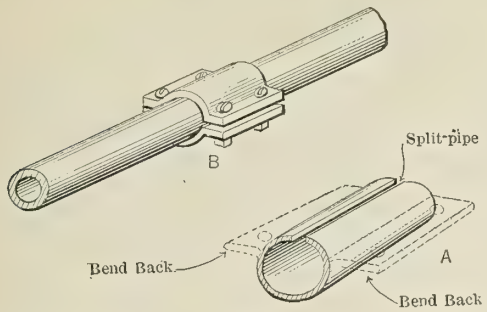


Fig. 2

patch made from blocks of wood, strong wire and some rubber gasket. These patches are adapted to large size pipes, such as condenser piping for emergency use until a better repair is possible by sweating on a copper patch or renewing the pipe.

For pin-hole leaks, the head of a common wood screw

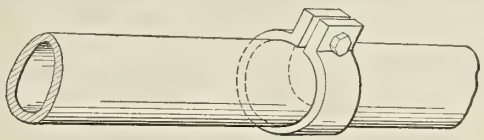


Fig. 3

cut off and used as shown in Fig. 6, with a bit of wire and gasket, is useful. The hole can be made to receive the screw by reaming out with the tang of a file.

Sometimes it is not possible to use any form of pipe clamps or bulky patches, due to the location of the pipe. When such a case is found, the sort of patch shown in Fig. 7 will be found very suitable and serviceable. The writer has used this method of making permanent repairs

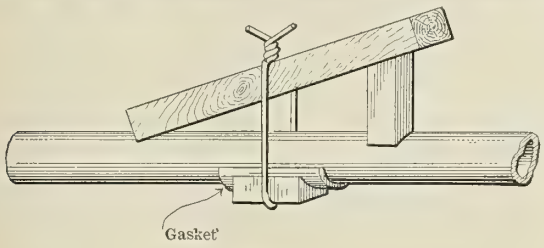


Fig. 4

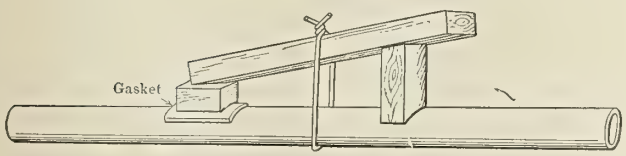


Fig. 5.—Temporary Pipe Patch

to several split pipes, for, when finished, shellacked over and painted, it does not present a bad appearance. The leaky or split pipe is wrapped with a piece of good gasket material, then with soft iron, brass or copper wire the gasket is bound tightly. The wire must be closely woven and the ends secured. Next a long, narrow strip of canvas is made and soaked in red lead. This is then wound on over the wire, making sure to overlap each layer and to continue on a little further than you wound the wire. After this is applied, take a roll of adhesive tape and start wrapping the pipe in the opposite direction, as shown, overlapping each layer. Make sure to bind all coverings very tightly and evenly. Shellac over the tape, and when possible paint it the color of the local piping.

The ring patch shown in Fig. 8 is a handy patch for small pipes. Cut off an annular section of a larger size pipe and drill and tap it for a set screw or bolt. Break the nearest joint or union and slip the ring on over the pipe. Work it along to the leaky place. Put a piece of gasket over the leak and inside the bottom of the ring, as

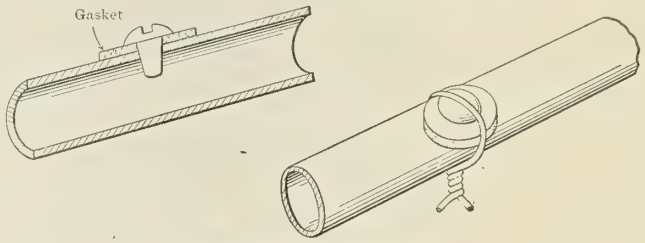


Fig. 6.—For Small Leak

indicated in the sketch. Place a protecting piece of metal under the point of the screw, set it up, and the patch is done.

The brazing at the flange joint on one section of the 14-inch main steam line sprung a leak on the writer's ship, and it continued to get worse in time, so much so that the whole interior of the compartment at the upper part would be all covered with moisture due to the condensed vapor adhering. Everything began to rust. We tried to calk the leak to lessen it, but it got worse. Now, it's no cinch to break down a section of 14-inch steam line with male and female joints. To repair it on board ship,

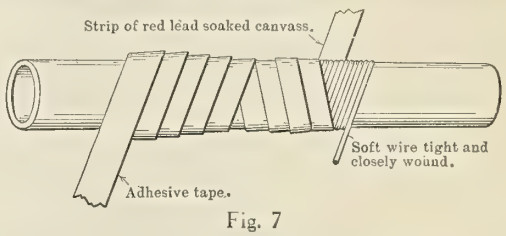


Fig. 7

and to do it with only a limited amount of time in a foreign port in these days of rush voyages, would have been worse. Some sort of a temporary repair had to be made, so we got to scheming, and the result was a packing clamp made in the ship's machine shop. A bar of 1¼-inch square stock was made into two half rings at the forge. The ends of these were lap-jointed, and then the ring was put in the lathe and bored to the diameter of the steam line 1/16-inch clearance, and one edge was faced conical. Two

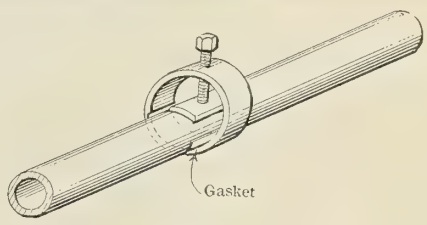


Fig. 8

views of the ring are shown in Fig. 9 at *C* and *D*. Four long, threaded bolts of the same diameter as those used in the joints were made, as at *A*, and four straps, as shown at *B*, the one end of the strap being bent over double to give bearing surface on the bolts. This completed the clamp.

A piece of spiral, high pressure packing was cut and

fitted to the diameter of the pipe, and then the two halves of the clamp were put on and bolted together with top screws. Four of the regular flange bolts were taken out (steam line dead), and the four special long bolts put in at 90-degree points. The packing was then put hard against the leak at the brazing and the ring drawn up against it by

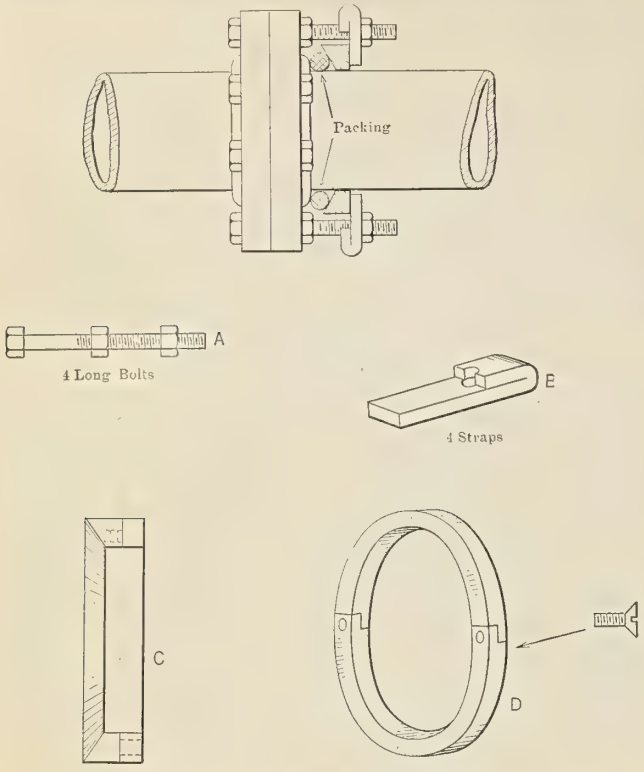


Fig. 9

the four straps, as shown in sectional view in Fig. 9. Steam was turned into the line and the packing again tightened. To our great pleasure, the leak was conquered.

Concord, N. H. C. H. Willey.

Indicator Test of Triple Expansion Marine Engine

This test was performed on the main propelling engine of the steamship *Mohawk,* of the Clyde Line Steamship Company, plying between New York City and Jacksonville, Fla., with Charleston, S. C., as an intermediate stop. The *Mohawk* is a combination freight and passenger steamer 380 feet in length, 48 feet extreme beam, with a gross tonnage of 4,623, and accommodations for 220 passengers. She was built by the Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., during 1907-08.

Steam is supplied by four Scotch boilers, 14½ feet in diameter, 11½ feet long, each having a heating surface of 8,500 square feet. These boilers have a safety valve which operates at 181 pounds gage pressure, but were tested when installed to 272 pounds per square inch hydrostatic pressure.

Forced draft is used, air being supplied by two Sturtevant fan blowers, which, with the assistance of a stack 76 feet high and 8 feet in diameter, gives an average draft of 1.3 inches of water.

These boilers are supplied with water from an open heater, which uses the condensate from the condenser, after same has been filtered. Any additional water which is added on account of unavoidable waste is drawn from a reserve supply taken from the bilges.

The water is heated in the open heater to an average temperature of 235 degrees F., a pressure of 14 to 18 pounds gage existing. The steam used for heating is that exhausted from the many auxiliaries used in connection with the plant. An ingenious scheme is employed in this respect, in that a valve is placed in the auxiliary exhaust, which permits steam above 18 pounds absolute to pass into the low pressure cylinder and thus work is derived from it.

The main engine is of the vertical, triple expansion, condensing type, having tail rods. The high, intermediate and low pressure cylinders are 27½ inches, 46 inches, 76 inches in diameter, respectively, with a common piston stroke of 42 inches. The cranks are set 120 degrees apart operating in this sequence, H.P., I.P., L.P., the steam from the low pressure cylinder being discharged into a surface condenser, which is built into the frame of the engine and through which sea water is circulated by means of a centrifugal pump.

The ratios of the volumes of the cylinders are as follows: High pressure, 1.00; intermediate pressure, 2.84, and low pressure, 7.78.

Single ported, balanced piston valves are fitted to the cylinders; one 12-inch valve for the high, two 12-inch valves for the intermediate and two 25-inch valves for the low pressure. The high pressure and intermediate pressure have 8-inch travels, while the low pressure has a 9-inch travel. All valves are controlled by standard Stephenson link motion. They take steam on inside edges.

The propeller is four-bladed, 14 feet in diameter, and 16.52 feet pitch, connected to the engine by a shaft 14¾ inches diameter and 70 feet long, made in four sections, each 17 feet 6¼ inches in length, supported by eight well-designed babbitt bearings, besides the thrust bearing.

In addition to the main engine, there were in the engine room two General Electric marine type electric generating units, the cylinder of each engine being 8 inches in diameter and 6-inch stroke, and coupled direct to a D. C. generator, developing 15 kilowatts at a voltage of 110. There was also a two-cylinder, cross coupled, horizontal engine, 6 inches by 8 inches, driving the steering gear.

There were also two fan blowers driven by engines 5 inches in diameter, 4-inch stroke.

The surface condenser contained 4,799 square feet of cooling surface, and was supplied by cooling water from a centrifugal pump, driven by a separate engine. The wet vacuum pump connected to the condenser was driven by a walking-beam from the intermediate pressure crosshead.

Three feed pumps, one fire and one sanitary pump and one ammonia compression refrigerating machine concluded the rest of the engine-room equipment.

The test was made during a voyage between the ports of New York City and Jacksonville, Fla., and return. Indicator cards were taken every half hour during each test. Four tests were made during the voyage.

The average steam consumption, as given by the pump displacement calculations and the indicator cards, is 11.9 pounds of steam per indicated horsepower per hour. This steam was supplied at an average boiler pressure of 175 pounds per square inch gage and with an average quality of 95 percent. The discharge pressure averages 2 pounds absolute. The actual thermal efficiency of the engine at these conditions is as follows:

Steam 175 pounds gage, 95 percent quality, total heat above 32 degrees F. = 1,155 B. T. U.
Consumption pounds per indicated horsepower per hour = 11.9.
Temperature of feed water, degrees F. = 235 F.
Heat per pound in feed water, 235-32, = 203 B. T. U.

Heat actually given to steam per pound, 1,155-203, = 952 B. T. U.

One horsepower in foot-pounds per minute = 33,000.

One horsepower uses 952 × 11.9 B. T. U. per hour = 113,200 B. T. U.

$$\text{One horsepower hour} = \frac{33{,}000 \times 60}{778} \text{ B. T. U. per hour} =$$

2,545 B. T. U.

$$\text{Actual thermal efficiency at 175 pounds gage} = \frac{2{,}545}{113{,}200} \times$$

100 = 22.4 percent.

The ideal maximum efficiency obtainable with the Carnot cycle was 29.4 percent. The actual thermal efficiency was 22.4 percent. This speaks well for the performance of the engine, since it is giving 22.4 percent efficiency out of a possible 29.4 percent.

The steam required to heat the feed water was worked out and it was found that the auxiliaries are supplying enough to give a feed water temperature of 235 degrees F., leaving no room for improvement in this respect.

Conclusions

It is very interesting to note that the indicated horsepower as computed six years ago is very nearly the same as was determined during this test, the difference being only a few horsepower. This tends to show that the engine is working under nearly the same conditions and is putting out the same power it did at that time. This also shows that there has been very little wear and tear, and no more losses are occurring than did occur at that time.

In connection with the steam consumption, no accurate determination of this was made. The reason for this was that there was no method by which the steam could be measured during this short test, because of the limited time of preparation. The pump from the condenser pumped out the air as well as the condensate, therefore the consumption of steam could not be calculated by the capacity of this pump. From the condenser the mixture of air and water was carried to the filter box, which could not easily be calibrated.

The feed pump delivering water to the boiler supplied enough for engine and auxiliaries, therefore a determination of the engine consumption could not be made. An approximation was therefore made by taking 10 percent of the total steam as being used by the auxiliaries. The total consumption was computed from the feed pump by multiplying the total displacement of the pump per stroke by the strokes per hour, and the cubic feet determined were then converted to pounds per hour.

The coal consumption, another important item in any test, could not be accurately determined because there was no way on shipboard whereby the coal used during a test could be determined. The total consumption during the trip was ascertained, but this was of little use, as coal was used during the stops at Charleston and Jacksonville, which ought not to be included in the consumption during the run, but which could not be separated from the total. For this reason no computation of coal consumption was made.

The mechanical efficiency could not be determined because the developed horsepower could not be found, because the actual thrust was not obtainable. In determining the thrust, the frictional losses were neglected. In other words, the mechanical efficiency was neglected. Of course, the actual thrust could be approximated by finding the resistance offered by the water to the passage of the boat, but this would not take into account any currents, and would, moreover, be a very complicated calculation.

As far as accuracy goes, the test gave a very good idea of the indicated horsepower of the ship.

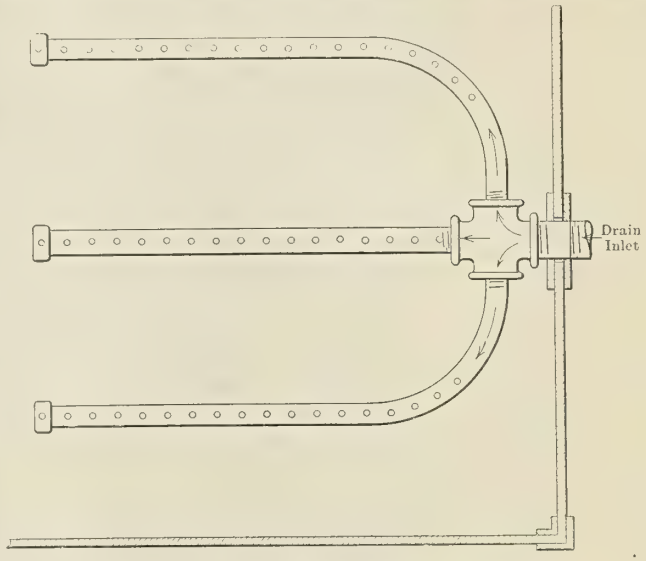
New York. A. C. De Lorme.

TABLE I—STEAM CONSUMPTION FROM CARDS

Run No.	R.P.M.	M.E.P.	I.H.P.	Lbs. Steam.		
				Per Rev.	Per Hr.	Per I.H.P. Hr.
1	103.20	92.37	3913	7.24	44912	11.50
2	103.60	93.48	3956	7.66	47726	12.05
3	100.82	88.10	3774	7.01	42020	11.63
4	102.15	83.10	3869	6.57	.....	10.42
					Average	11.40

Feed Tank Drain Silencer

The hot returns going into our feed tank from the drain lines always caused a hammering and rattling, clattering noise, due to the inrush of hot water and steam into the large body of cooler and dormant water. The distributing pipe of this troublesome arrangement was nothing more than a straight lead of 4-inch pipe drilled full of holes. The writer felt that if the drains were better distributed over a larger area less noise would be had and better results obtained.



Arrangement of Perforated Piping in Feed Tank

The scheme of piping shown in the sketch was used, reducing the size of the pipe to 2½ inches and drilling sufficient ¼-inch holes to give full volume outlet to each pipe. The chief was highly pleased, for the water was heated to a higher degree, which put less work on the feed water, enabling the reducing of the back pressure of the exhaust line, which we all know means economy.

TABLE II.—STEAM CONSUMPTION BY CALCULATION FROM FEED PUMP DATA

Run No.	Strokes Per Hr.	Piston Displ.		Cu. Ft. Pumped Per Hr.	Temp. Water.	Lbs. Pumped Per Hr.	90% Used By Main Engine.	Average I. H. P. For Run.	Lbs. Per I. H. P. Hr.
		H. E.	C. E.						
1	3756	.2632	.2265	920	235	54593.0	49133.5	3913	12.5
2	3720	.2632	.2265	912	235	54120.0	48652.0	3956	12.3
3	3550	.2632	.2265	868	235	51516.0	46452.0	3774	12.3
4	3727	.2632	.2265	912	235	54201.0	48750.0	3868	12.6

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding Will Be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so.

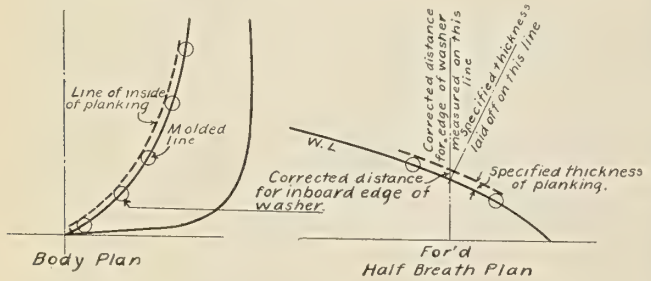
There will appear in this column from time to time questions which have been asked by the Board of Steamboat Inspectors in the various examinations for engineers' licenses conducted by them. Such questions will be denoted by an asterisk (*) placed before the number if from examination for grade of chief, and by a dagger (†) if from examination for other grades.

Projected Length of Normal Thickness of Wooden Ship's Planking

Q. (952).—(a) Will you please show a practical method of obtaining the projected length measured along a transverse section of the ship, of the normal thickness of a wooden ship's planking, i. e., the deduction at each section line for the thickness of a ship's planking?

(b) The theory involved would also be highly appreciated as I think descriptive geometry is one thing and its practical application very often entirely another.

A. (952).—The following method is used in some of the best yards in Great Britain; it is sufficiently accurate, and will be found, I think, to be one of the fastest and simplest methods in use. After the molded lines (to the outside


Line of inside of planking
Molded line
Body Plan
W.L
Corrected distance for edge of washer measured on this line
Specified thickness laid off on this line
Corrected distance for inboard edge of washer
Specified thickness of planking.
For'd
Half Breath Plan

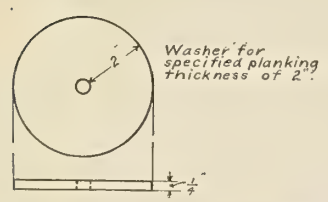


Fig. 1

of planking) have been laid down on the mold loft floor, washers are made of ¼- or 3/16-inch plate, with a difference of radii measured from the edge of the hole to the outer edge, equal to the thickness of the planking specified. These washers are slipped over pins driven into the floor on the molded lines of the body plan and then the batten is run tangent to the washers. This gives the transverse section taken to the inside of the planking or the outside of the frame, with sufficient accuracy for the frames lying amidships where the waterlines are parallel to the center line, or nearly so. Forward and aft, where the waterlines have an appreciable angle with the center line, the washers on the body plan sections must be adjusted inboard to correct for it. This corrected distance is obtained by laying off in the half breadth plan normal to the waterline the specified planking thickness and measuring the equivalent thickness parallel to the cross-section plane. The inboard edge of the washer on the body plan station is then set this distance from the molded line. (See Fig. 1.)

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Method of Finding Harpin and Ribband Lengths to Mark Frame Spacing

Q. (953). Please give the best method of finding harpin and ribband lengths so as to mark on them the correct frame spacing before erecting.

A. (953).—After the ribband is drawn in the body plan obtain its projection in the sheer plan. Pin a flexible batten on it and mark the stations; let the batten be straightened into a horizontal line, keeping the F. P. in

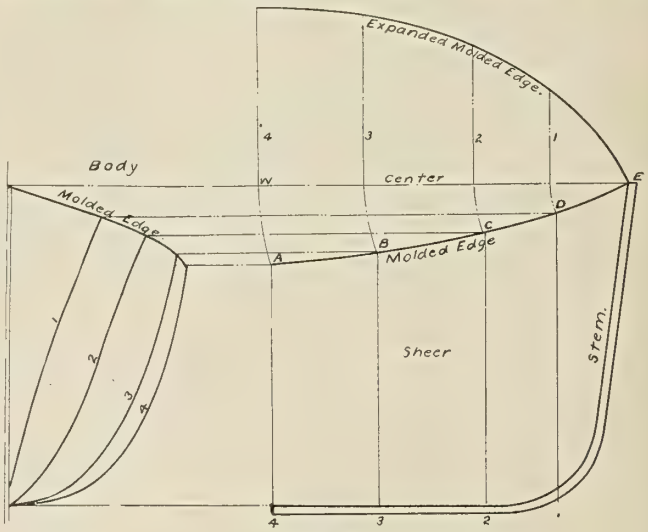


Fig. 2

agreement. This gives the new station positions for the developed or flattened sheer condition. On these expanded stations lay off the half breadths measured from the body plan (See Fig. 2). Watson's "Manual on Laying Off" (Longmans, Green & Co., N. Y.) devotes a chapter to ribbands and harpins, which gives complete information. The above sketch is modified from that.

Propulsion Problem

Q. (958).—Will you kindly work out and explain the following: If a ship makes 18 knots on 100 revolutions per minute and 25 percent slip, what will she make with 120 revolutions per minute and 20 percent slip?

A. (958).—Speed in knots is equal to the product of one minus the apparent slip, the pitch (in feet) and the revolutions per minute, the whole divided by 101.3, which, expressed as an equation, is as follows:

$$V = \frac{(1 - S)\, P \times R}{101.3}$$

For the first case $V_1 = 0.75 \times P \times 100 = 75\,P$

For the second case $V_2 = 0.80 \times P \times 120 = 96\,P$

The two conditions are not compatible, however, for a given hull and the same propeller as the apparent slip increases with increasing revolutions per minute or speed.

Difference Between Angle of Advance and Angle of Lead

Q. (955).—Please explain the difference betwen angle of advance and angle of lead.

A. (955).—The difference between angle of advance and angle of lead may be understood from a study of their definitions.

The angular distance through which the eccentric is moved in order to shift the valve from its mid-position to that which it should occupy at the beginning of the stroke is called the *angular advance* of the eccentric.

The angular distance between the positions of the crank at the time of admission by the valve and when the piston is on the dead-point is called the *angle of lead.*

From the definitions it may be seen that angle of lead refers to the crank, and angle of advance, to the eccentric.

Design of Tugboat

Q. (954).—(a) Please give an intelligent method of designing a tug boat. I know that their average speed is from 15 to 16 miles, slip 20 percent, with a good tow approximately 50 percent slip, and with a ship or something that cannot move the slip is unity. But I would like to have discussed a method of approaching the problem from another angle, —i. e., having given a tow of 15 or 16 barges—110 feet by 30 feet by 7 feet, with a 15 foot rake ending 3 feet down from deck, and loaded to rake edge. Which is the best method of going at the design in order to get just sufficient power to drive the tow 3 miles per hour against a 3 mile current?

(b) Also an intelligent outline of the best form of keeping data for such a problem in order to design a hull which will just envelop the required machinery without building too much tug—i. e., the best method of proportioning the dimensions of hull after arriving at the proper indicated horsepower to do the work of towing.

(c) Can any law of comparison be applied to such a problem with barges to tow? Such problems will certainly come up in connection with our inland water ways and rivers.

A. (954).—(a) A detailed answer to your question is beyond the scope of this column, but a brief resumé of the steps and the order in which they should be taken is given below:

First.—Estimate the curve of resistance on speed for the tow.

Second.—Do the same for a tug of assumed dimensions approximately sufficient for the work.

Third.—Construct the final curve of total resistance on speed by adding 2 to 3.

Fourth.—The resistances at each speed multiplied by that speed will then give the curve of effective horsepower on speed for the tug and her tow.

Indicated horsepower × efficiency of engine × efficiency of propeller × hull efficiency = effective horsepower, and conversely effective horsepower ÷ efficiency engine ÷ efficiency propeller ÷ efficiency hull = indicated horsepower.

Fifth.—Estimate each of the efficiencies noted for the 6-mile condition and divide the effective horsepower at 6 miles (3 miles speed + 3 miles current) by the continued product of these three efficiencies to get the estimated indicated horsepower.

It is desirable to do this for other speeds above and below and construct a piece of the indicated horsepower on speed curve.

Sixth.—Select the indicated horsepower found necessary and estimate the weight of propelling machinery.

Seventh.—Estimate the dimensions of a hull just sufficient to carry this indicated horsepower with its fuel, etc.

Eighth.—The dimensions thus obtained will probably not be those at first estimated under No. 2, but should not be far different. Now repeat the procedure outlined above with the new hull dimensions, thus obtaining the final estimate.

For excellent data on the resistance of barges under tow efficiencies, machinery weights, etc., see the following reference: *Experimental Towboats,* U. S. House of Representatives, 63d Congress, Document 857—Report on Two Experimental Towboats with a Complement of Suitable Barges . . . . for Towing and Delivering along the Mississippi River and Its Tributaries.

Also see Marine Engineering, February, 1917.

(c) The laws of comparison hold for conditions of similitude and are one of the best helps in designing. The first reference cited above gives a table of dimensional formulæ (P. 16), showing according to what function of speed and displacement the various characteristics vary.

Horsepower of Boiler

Q. (957).—Here is a case hard to beat. I am in charge of a 150-horsepower straight line engine. Steam is furnished by a single furnace dryback marine boiler—no dome; stack is about 3 feet wide and 65 feet high. There are seventy-two 2½-inch tubes, 12 feet long. The furnace is 40 inches by 10 feet of 7/16-inch metal of the Morrison style. At a rough guess what horsepower would you say it is?

A. (957).—In stationary practice it is customary to rate a boiler on the basis of 10 square feet of heating surface = 1 horsepower. This method of rating a boiler is *arbitrary,* has been adopted simply as a *matter* of *convenience,* and assumes that 10 square feet of heating surface under normal operation are capable of evaporating 34.5 pounds of water per hour from and at 212 degrees F.

For your case the heating surface is

$$72 \times 12 \times \frac{2.5 \times \pi}{12} + \tfrac{1}{2} \times 40 \times \pi\ 10 = 565 + 628 = 1{,}193$$

square feet, approximately.

According to the above custom of rating, this would be sold for a boiler of 1,193 ÷ 10 = 119 nominal boiler horsepower. To correct this estimate for the feed temperature of 50 degrees F. instead of 212 degrees, assumed, the factor of evaporation would be about 1.20, giving a rough estimate of the horsepower in accordance with the A. S. M. E. rule (34.5 pounds water from and at 212 degrees) of 119 ÷ 1.20 = 100 boiler horsepower, approximately.

Pressure and Heat Engines

Q. (960).—Will you kindly explain just what is meant by pressure and heat engines, as referred to in "Practical Marine Engineering," by Rear Admiral C. W. Dyson, in Section 29, third paragraph?

A. (960).—The distinction is not a good one, for both are heat engines in the commonly accepted meaning of that term; i. e., an engine which transforms heat energy into work. The heat energy having been given to the steam is tranformed into work in the first case via an expansion in which the steam continually presses against a piston; but in the second case the expansion simply produces velocity in the jet of steam with its attendant kinetic energy, which, via the rotor, is transformed into work. Practically all of our prime movers of to-day, except electric ones, are heat engines.

Procedure When High-Pressure Crank Pin Breaks

Q. (961).—If the high-pressure crank pin of a triple-expansion engine broke at sea, how would you proceed?

A. (961).—If the necessary spare parts are not available stop the engine immediately, remove broken parts and connecting rod. Secure piston at the bottom of its stroke by clamping slipper to the guides; this step is not necessary unless the bottom steam port is open when the piston is resting on the bottom cylinder head. By-pass steam to the intermediate and then operate engine at reduced pressure by throttling or allow steam to pass through high pressure cylinder to the intermediate cylinder.

CONCRETE SHIP BUILDING IN SPAIN

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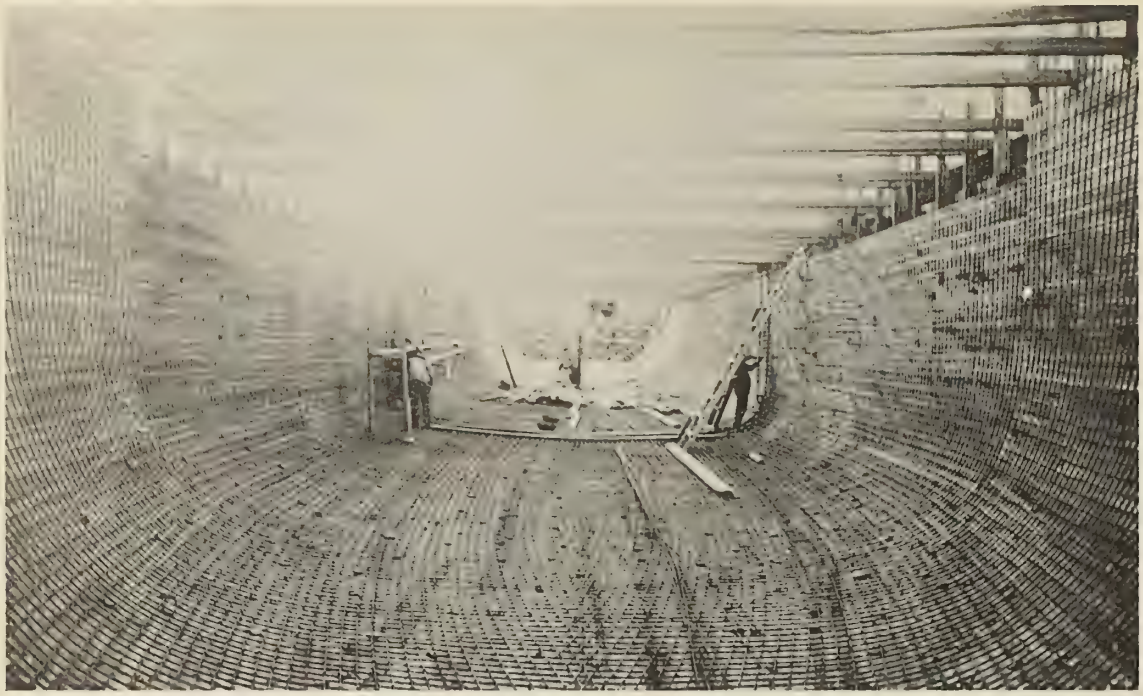
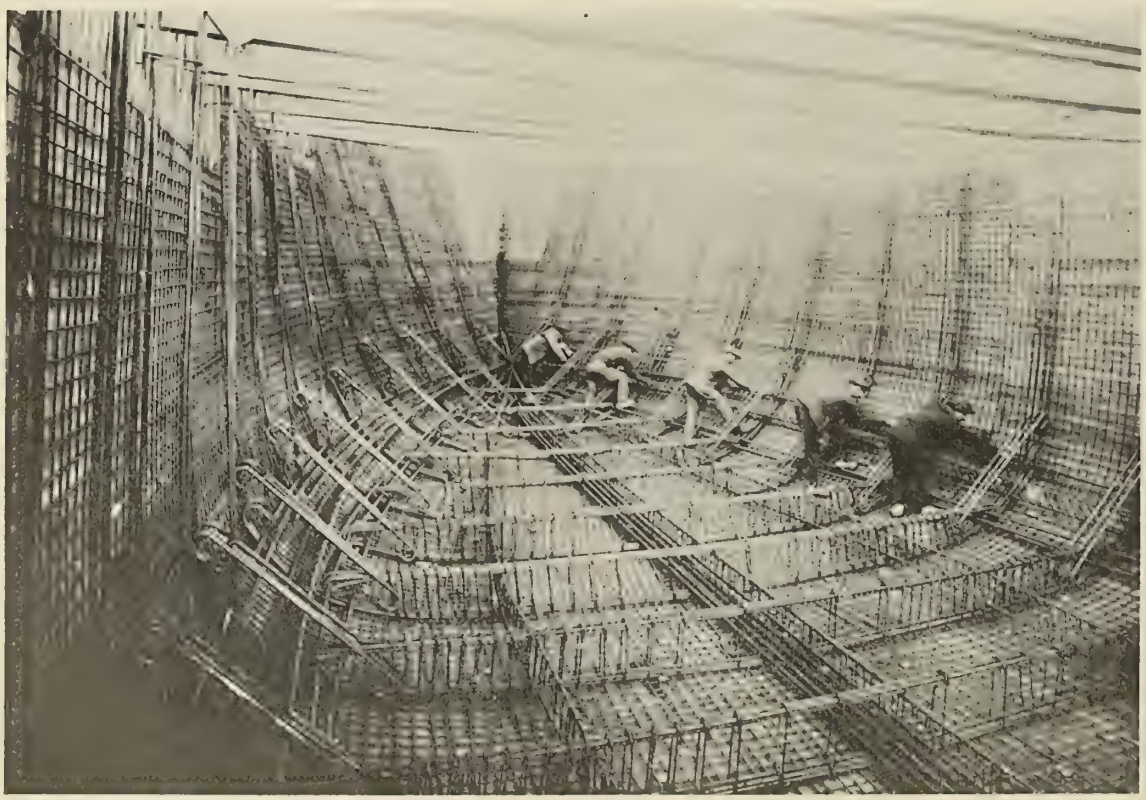


Concrete Ship Building by Works and Pavements, Barcelona, Spain



Laying the Bilge Reinforcement

Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

SHIPPING SUNK DURING THE WAR TOTALS 11,827,527 TONS

Tonnage Built Amounts to 6,606,275 Tons

Figures Issued by British Admiralty

Three statements compiled by the British Admiralty were recently published by the British Embassy in Washington giving shipping losses by enemy action and marine risk, mercantile shipbuilding output and enemy vessels captured and brought into service from the beginning of the war up to January 1, 1918.

These statements show that 11,827,527 gross tons of shipping have been sunk, of which 7,079,492 gross tons belonged to the United Kingdom and 4,748,080 gross tons to other countries. Against these losses 6,606,275 gross tons of shipping have been built, 3,031,555 gross tons by the United Kingdom and 3,574,720 gross tons by other countries. Added to this 2,589,000 gross tons of enemy vessels were captured and brought into service.

DECREASE OF 2,500,000 TONS

According to recent statements made before the House of Commons by Sir Eric Campbell Geddes, First Lord of the Admiralty, the world's tonnage, exclusive of enemy ships, had fallen 2,500,000 tons from the beginning of the war to the end of 1917. The total allied and neutral tonnage is now 42,000,000 tons, he said, and the tonnage sunk in the last twelve months was 6,000,000. During the last quarter of 1917 the Allies were averaging within 100,000 tons monthly of making their losses good, and were then replacing 75 percent of their lost tonnage.

At the present time 47 shipyards in Great Britain, with 209 berths, are engaged on ocean-going merchant vessels, and the output in repair work had increased in February, 1918, as compared with August, 1917, by 80 percent.

Bethlehem Steel Corporation's Part in the Shipbuilding Programme

According to a statement made by C. M. Schwab, chairman of the board of directors of the Bethlehem Steel Corporation, in the annual report to the shareholders, there were on the books of the Bethlehem Steel Corporation, at the close of 1917, orders for naval and merchant vessels to an aggregate value of $273,000,000. Mr. Schwab predicted that deliveries of these vessels would probably be completed on schedule time.

Other Government and private contracts brought the total of unfilled orders on December 31 up to $453,808,759. As an indication of how completely the capacities of the Bethlehem Steel plants are being utilized, the contracts on hand on January 1, 1914, prior to the outbreak of the European war, aggregated only about 5 percent of this total.

Shipbuilding for Beginners

Volunteer shipyard workers can obtain from the United States Shipping Board Emergency Fleet Corporation, Washington, D. C., for the asking, a copy of a book entitled "Shipbuilding for Beginners," prepared by Assistant Naval Constructor A. W. Carmichael, U. S. N., which tells the man in the shipyard what he is to do, why he is to do it and how he should do it.

This little volume will be found a valuable asset in every shipyard in the country where beginners are taking up the unfamiliar task of building ships.

Annual Meeting of Institution of Naval Architects

At the annual meeting of the Institution of Naval Architects, held in London, March 20 and 21, the following papers were read:

"Standard Cargo Ships." By Sir George Carter, K. B. E.

"The Most Suitable Sizes and Speeds for General Cargo Steamers." By John Anderson.

"Problems of the Future in the Design and Construction of Merchant Ships." By W. S. Abell.

"On the Value of Research Work in Marine Engineering." By A. E. Seaton.

"The Effect of Longitudinal Motion on a Ship and Its Statical Transverse Stability." By G. S. Baker, O. B. E., and Miss E. M. Keary.

"The Iron Carbide Equilibrium Diagram and Its Practical Usefulness. By Prof. H. C. H. Carpenter.

"Stress Distribution in Bolts and Nuts." By C. E. Stromeyer.

"A Preliminary Study of the Possibilities of Reinforced Concrete as a Material for Ship Construction." By Major Morris Denny.

"Reinforced Concrete Ships." By Walter Pollock.

"Design and Construction of the First Self-Propelled Reinforced Concrete Seagoing Cargo Steamer Built in Great Britain." By T. G. Owens.

"An Investigation of the Shearing Force and Bending Moment Acting on the Structure of a Ship, Including Dynamic Effects." By A. M. Robb, B. S. C.

"Air Supply to Boiler Rooms." By R. W. Allen, C. B. E.

NAVAL APPROPRIATION BILL CARRIES A TOTAL OF $1,327,600,000

Construction of Destroyers and Submarine Chasers Rapidly Progressing

Three-Year Naval Programme to Be Resumed

The annual naval appropriation bill recently reported to Congress calls for an appropriation larger by over $800,000,000 than any prior naval bill, carrying in round numbers $1,327,600,000. This sum, according to a statement of the Secretary of the Navy, together with last year's bill and the supplemental appropriations carried in the two deficiency bills of the preceding session, make almost $3,000,000,000 provided for the navy in a little more than twelve months. The total expenditures of the navy from 1794 to 1916, inclusive, a period of 122 years, only exceeded this sum by three hundred and sixty odd million dollars.

The bill provides the money necessary to carry forward the three-year programme of battleships, battle cruisers and other types of ships already authorized. It also provides another emergency fund of $100,000,000 which may be used for the construction of destroyers and other small craft, which are the present most pressing need in the fight against the submarine menace.

The work of building destroyers has progressed rapidly, and in addition to the large destroyers contracts have been let for a large fleet of specially-designed 200-foot submarine chasers. A large number of these smaller destroyers will be built at the Ford plant in Detroit and at a new Ford plant on the Newark meadows, New Jersey.

In accordance with the recommendations of the Secretary of the Navy, this bill increases the enlisted strength of the navy for the period of the war from 87,000 to 180,000 men, irrespective of apprentice seamen, hospital corps, men of the aviation branch and men in training in trade schools, and also temporarily increases the enlisted strength of the marine corps from 30,000 to 50,000 men.

Nearly $200,000,000 is provided for aviation purposes. For the expansion of existing navy yards and naval stations and to equip a number of yards for the construction of capital ships, torpedo boat destroyers, submarines and auxiliaries, the bill carries $12,000,000 for the Bureau of Yards and Docks. For ordnance purposes the bill provides the sum of $167,000,000. This, with the sums and authorizations in the recent urgent deficiency bill, makes a credit of over $600,000,000 for navy ordnance alone in the space of twelve months.

HOW BUSINESS EXECUTIVES CAN HELP THE SHIP-BUILDERS

Organized Efforts Will Solve Local Problems

The key to the whole ship question is that the business men of the country must know the need for ships; and that they be educated to the idea of ships; that they be organized to force and further the building of ships; and that they become, when so organized, the medium through which things will get done in their several communities, is the recent statement made by Edward A. Filene, chairman of the War Shipping Committee of the United States Chamber of Commerce.

There can be no question of their willingness to help. The most insistent inquiry that comes to Washington is "How can I help? What can I do? Show me the way!"

The answer comes from the War Shipping Committee of the Chamber of Commerce of the United States. It calls on every business organization in the country—particularly the organizations in shipbuilding communities—to organize for the carrying out of a well-defined programme for local action.

Practical Aid

It calls on them to sit in with the shipbuilders once a week, and actually go over their problems, to find out just how they can help. It is not at all the same thing as making a general blanket offer to help, and then sitting back to await the call. That has been tried, and it has failed. The need is for active and continued counsel through which the business men of the community seek, without officious interference, to relieve the shipbuilder of as many of his non-technical problems as he needs to be relieved of.

For example, the traffic expert of a business association can be of great assistance to shipbuilders in getting materials for their work if he be free to give such help and makes it his first duty to do so.

Carrying Workmen to the Shipyards

Of capital importance also is the question of carrying workmen to and from their work. The car lines in many communities are unable to meet the extra load which the influx of thousands of workers has put upon them. Some communities have had to solve the problem by changing the local business schedule by opening stores and offices a half hour later in order to have two peak loads, and so give the workmen a rush hour of their own each morning.

It may even mean that the local business organization must requisition the services of owners of private automobiles to carry men to and from their work. Think of the opportunity there for the shipbuilding community whose business men are organized for action! Think of what it would mean if this were regularly done, and if the workmen of the plant saw daily a string of hundreds of automobiles, from flivvers to the finest made, waiting to carry them, at considerable sacrifice and inconvenience, so that they might do their work for the nation to the best advantage! Can one imagine such workmen striking, or delaying ships, or refusing to adjust their differences with their employers through established boards of arbitration?

Housing Problem

The housing problem is one of the most serious we have to face. Cantonments and houses will be built. The Government has just appropriated $50,000,000 for that purpose. But they will not be ready in less than six months, and we cannot wait. Here, again, the organized business men of the community must solve the local problem; and they must see to it that the citizens of their community, regardless of questions of personal convenience, shall take these workmen into their private homes till other accommodations are ready. Care could be taken, of course, to make careful choice of the right man for the right home. Indiscriminate distribution of men through all classes of homes would be unnecessary. But the fact remains that the thing must be done, whether or no, and done at once.

"Every shipbuilding community should adopt a definite policy of recognition in its relations with the ship workers. I have in mind several incidents that will serve to leave a concrete impression of this fact in the reader's mind," said Mr. Filene.

"On a recent trip to a shipbuilding city in the South I saw a new ship that had been lying idle at a certain Gulf port because it had no anchor chains. The owner could not get them, though he had sent frantic appeals to Washington. I asked certain business men there if they could not have gotten those chains if they had undertaken it in behalf of that shipowner. They said they believed they could have put it through; and they said they would make the attempt at once. The notion of doing such a thing simply had not occurred to them.

"Here is a second example. In another city there was a grade crossing where freight trains blocked the approach to a shipbuilding plant. In consequence the workers were delayed in stormy or fair weather every morning and evening—sometimes as much as twenty minutes. The Chamber of Commerce, which had organized to help the local shipbuilders, took hold of the difficulty and had a bridge over that crossing in record time.

"In still another city a delay of weeks in the installation of electric power necessary for building ships was settled within three hours after the local Chamber of Commerce found out from the shipbuilders how they had been delayed.

"So much for the vital facts. They all point to one conclusion that cannot be understood too clearly—helping to build more ships is the most important war job at this time. The man or organization that successfully helps in this is doing a job which at this time is more important than that of the man with the gun."

Fencing and Lighting of Shipyards Ordered

An order sent to the district officers and supervisors by the vice-president and general manager, March 4, directs that proper provision be made for fencing and lighting of plants building ships for the Emergency Fleet Corporation.

BUILDERS OF WOODEN SHIPS URGED TO CO-OPERATE TO SPEED PRODUCTION

Frequent Meetings of Shipbuilders in Each District Suggested

James O. Heyworth, manager of the division of wood ship construction of the Emergency Fleet Corporation, issued a circular letter last night to all wood shipbuilders, as follows:

From personal inspection of yards, and from the reports of our traveling engineers, it is very evident that the methods of construction, elasticity of plants and equipment, and storage equipment and facilities are different in the different yards.

Some yards can work 300 to 400 men per ship at the time when the peak of construction of the ship is ready for them; other yards can work rarely more than 160 to 200 men per ship; even some of the old shipbuilders believe 100 to 125 men per ship is the limit for good construction.

Can Rely on Drawings

It must be remembered that in the Ferris standard type the plans are so accurate that much of the woodwork can be done with safety by sawing to the exact dimensions. For your information, there are yards where the old shipbuilder was doubtful whether he dared saw to the exact size, leaving from 1 to 3 inches that could be hand reduced after the timber was in place, taking this precaution to be sure that the alinement of the ship would come out right. Experience shows that the plans and drawings can be relied upon.

We have records of yards where they have put as high as 500 men on a ship to advantage. In one yard this has recently caught up previous delay by over two months. We have numerous yards where 300 to 400 men are worked to advantage on one ship. Other shipbuilders that I have personally talked to were fearful of either economic, or, from the production standpoint, that over 150 men per ship could be worked.

This wide variation in conception of the possibilities in construction can be very quickly remedied, as is being done in many yards to-day, and all future production materially increased if the following suggestion is carried out:

The shipbuilders in each district should form an association and meet at least once in every two weeks; remember that a week from now is equal to one month in ordinary times. The district supervisor should meet with this association; the meeting should be formal and carried on in a business-like manner, straight to the point, viz.: To illustrate by photographs and drawings, or papers, or brief talks, the advantages certain yards are obtaining by their methods and equipment and general handling of construction. The minutes of these meetings should be immediately put in proper form and distributed among the shipbuilders of the district, as well as a copy to the home office.

I shall be very glad to receive your comments, but the Emergency Fleet Corporation will be more interested to know

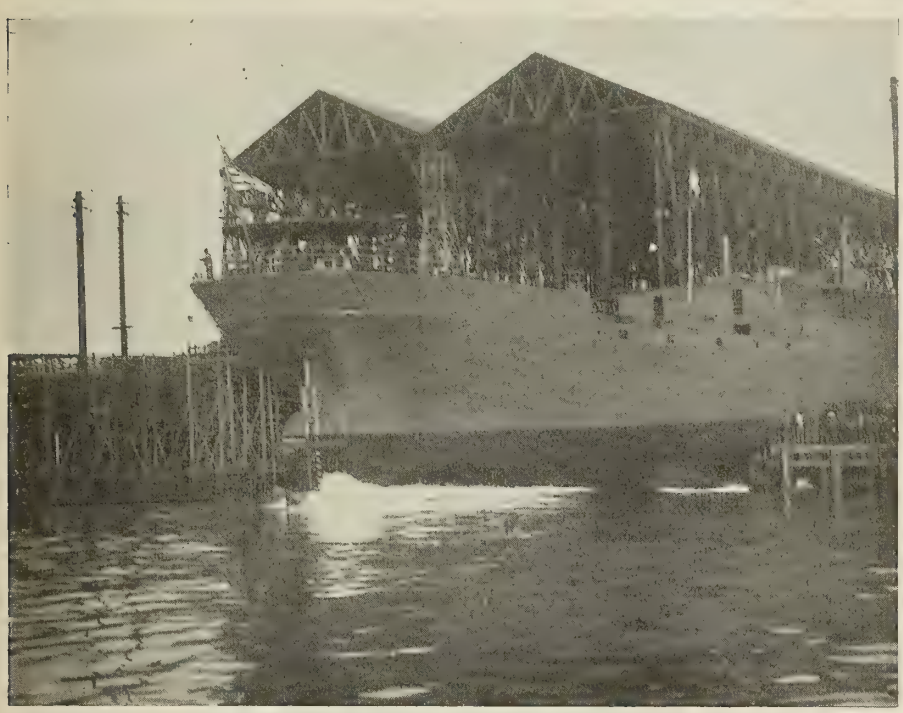
that some such plan of action has been adopted and put into working effect.

Must Speed Up Production

This is no time to work on the old basis for wood ship construction. The country needs ships more than anything else. We must have them. Production must be speeded up.

It is logical that a general comparison can be made where so many yards are at work, and it is also logical that many of the yards are being operated along better lines of production than other yards. It is your duty and obligation to the soldiers abroad to take the utmost advantage of this fact and act accordingly.

This division is developing engineers, traveling principally for the purpose of arriving at how the yards are doing at best. Co-operation with these engineers will help, but real co-operation between the shipbuilders of each district, worked out in a proper manner, can double our production in the next six months.



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Launch of the 8,800-Ton Steel Steamship *Ossineke* at Skinner & Eddy Yard—the Second Vessel to Be Launched from This Yard Within 64 Working Days from the Laying of the Keel

New Orleans Shipbuilding and Port Development

The creation of a lock, fixed-level ship basin, and industrial canal at New Orleans, which has been undertaken through the co-operation of officials and commercial interests of that city, will make possible a great development of the commerce of the port and furnish shipbuilding facilities which promise to be of special value to the nation under existing conditions.

The project will have an economic effect on the trade and industry of twenty-one States, or 49 percent of the total area of continental United States—the Mississippi Valley. It has been made possible through proceedings which have extended over a period of four years, and the fruition will come at a time when the shipbuilding features are of particular general interest. Mayor Behrman, of New Orleans, already has conferred with Chairman Hurley, of the United States Shipping Board, with the object of making the best use of these facilities. He is convinced that the city would be lacking in its duty to the Government if it did not create shipbuilding facilities by turning its favorable topography to immediate account. The lock, basin and canal will connect the Mississippi River with Lake Pontchartrain, which is a navigable arm of the Gulf of Mexico, six miles away, and the enterprise, as a whole, is expected to furnish ideal terminal facilities.

Small Ships Excluded from Transatlantic Voyages

Steamers of less than 2,500 deadweight tons will not be permitted to clear for a transatlantic voyage or to engage in other long-voyage trade, under orders recently promulgated by the Shipping Board.

"This ruling has been adopted," it was announced, "as a measure of conservation and economical use of tonnage, since, in the board's judgment, steamers of small tonnage are uneconomical and unsafe in the trades in question. Steamers so excluded will be employed in the coastwise, West Indies or other appropriate services."

To obtain a further measure of control over ships of less than 2,500 tons and over sailing ships, the Shipping Board is contemplating the requisitioning of all American tonnage not already taken over. All steamers of more than 2,500 tons already have been taken over.

AMERICAN SHIPYARDS SHOULD PRODUCE 1,600 SHIPS THIS YEAR, SAYS CHAIRMAN HURLEY.

Yards and Half a Million Men Ready

In a brief address at a recent Army and Navy benefit in New York, when Sousa's march, "The Volunteers," dedicated to the shipbuilders of America, was rendered for the first time, Chairman Hurley said:

"We have the shipyards practically completed. The materials will be in the yards very shortly. We require man power and the support of the American people. Our task is a serious one. It will take millions of tons of shipping to overcome the menace of the submarine, but with the American workman—who is the most skilled and efficient in the world—and efficient management in the shipyards, I am optimistic as to the tonnage we will produce this year.

Progress Getting Its Stride

"We have 130 shipyards, with 700 ways, and a half million men. We should produce about 1,600 ships. The winter has been the most severe in many years, but our programme is now getting into its stride. I am glad to tell you that during this month we expect to place in service twenty-six complete ships, and launch thirty-four in addition.

"It has been gratifying to me to learn of the response which has been made to the call for the Shipyard Volunteer Reserve of 250,000 additional workmen, who stand ready to go to the shipyards when needed. Every State has been heard from in wonderful numbers."

Indian Names Selected for 120 New Ships by Mrs. Woodrow Wilson

The 120 vessels to be launched by the American International Shipbuilding Corporation from the Hog Island ways have been named by Mrs. Woodrow Wilson, wife of the President.

The names selected by Mrs. Wilson are of pure Indian origin, many of the most familiar tribes being thus appropriately recognized.

Maxim "Non-sinkable" Ship to Be Built

The Shipping Board has decided to build a vessel along the line designed by Hudson Maxim. Several methods for protecting vessels from submarine attack have been considered, and the board is now engaged in making special tests of these. Mr. Maxim's principle is along the line of inside protection—that is, intended to keep a vessel afloat after it has been damaged by a torpedo.

Merchant Marine Growing

The growing American merchant marine was increased by 399 seagoing vessels in the last six months of 1917, Government officials report, or an average of more than two a day.

Figures previously made public showed that more than 1,000,000 tons of shipping were added to the American merchant marine in 1917.

NEW SHIPYARDS AND EXTENSIONS PLANNED

Three Companies Organized to Build Concrete Vessels

The American Concrete Shipbuilding Company has been organized at Tacoma, Wash., with the intention of building concrete ships of large size. L. Y. Stayton is president.

The Galveston Dry Dock & Construction Company, Galveston, Tex., has been incorporated, with H. H. Langham president, and T. J. Anderson, consulting engineer. The company is planning the construction of a floating dry dock and machine shops, to cost nearly a million dollars.

Work has been begun at Toronto on the two million dollar shipbuilding plant of the Thor Iron Works. This shipyard, of which Christoffer Hannevig, Inc., 139 Broadway, New York, is the parent concern, is the Dominion Shipbuilding Company. A permit has been obtained to erect a $175,000 work shop and general machine plant.

The Norfolk Concrete Boat Company has been organized at Norfolk, Va., with a capital stock of $1,000,000. Fred Doty is president of the company, which is planning the construction of a shipbuilding plant on the Elizabeth river.

The West Coast Shipbuilding Company, Everett, Wash., has been incorporated for the purpose of building concrete ships for the French government.

The Curtis Bay Shipbuilding Company has been incorporated, with a capital stock of $2,000,000. It is planning to build a yard at Curtis Bay near Baltimore, Md., for the construction of steel ships.

The Weehawken Dry Docks Company, Weehawken, N. J., has purchased more than seven hundred acres of land near Peekskill, N. Y., on the east bank of the Hudson River, and will, according to report, spend about $4,000,000 for a shipyard. The company is also reported to have received contracts from the United States Shipping Board to build fourteen steel vessels of 7,500 tons, twelve concrete vessels of 3,500 tons and one hundred barges.

The Continental Shipbuilding Company, Selah Masten, president, has opened an office at 103 Park avenue, New York, and will soon be in the market for the equipment necessary for its new steel shipyard at Yonkers, N. Y.

The Ferro-Concrete Shipbuilding Corporation, 149 Broadway, New York, and the Fougner American Steel Concrete Shipbuilding Company, 18 East Forty-first street, New York, are planning to build shipyards on the Atlantic coast for the construction of concrete vessels for the United States Shipping Board.

The Foundation Company, 233 Broadway, New York, which has built several shipyards on the Atlantic and Pacific coasts, is planning the erection of another plant on the Savannah River near Savannah, Ga.

The Francis Cobb Company, Rockland, Me., has been taken over by the Francis Cobb Shipbuilding Company. The shipyard will be enlarged to take care of new contracts. The officers of the new company are H. Nelson McDougall, president, and Benjamin C. Perry, treasurer and general manager.

The Potomac Shipbuilding Company, Quantico, Va., is planning the construction of a shipyard to cost about $200,000. George R. Collins, Colorado building, Washington, D. C., is president.

Work on the plant to be built by Henry Ford on the meadows near Jersey City, N. J., for the construction of submarine chasers, will be rushed, with the intention of allowing operation before July 1.

The United States Shipbuilding Corporation, San Diego, Cal. (formerly located in Los Angeles), has begun the erection of a steel fabricating shop and will specialize in the construction of all-steel vessels.

The American Shipbuilding Company, Colon H. Livingstone, president, 1249 Kenyon avenue, N. W., Washington, D. C., has had plans and specifications drawn by Frederick T. Ley, Springfield, Mass., for a shipbuilding plant at Jones' Point.

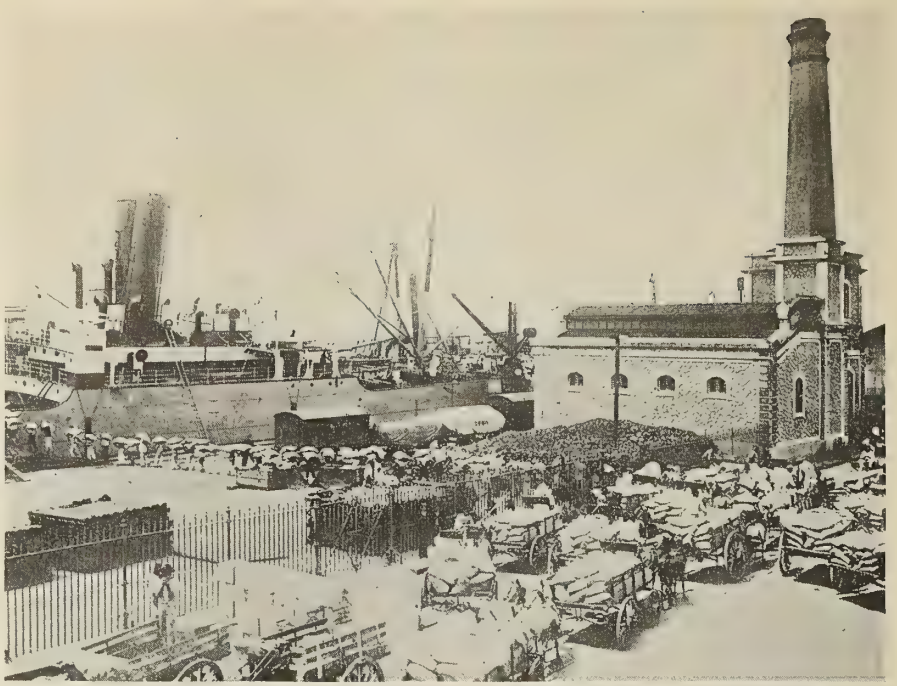
The Mobile Shipbuilding Company, Mobile, Ala., W. L. Kelly, president, has increased its capital stock from $100,000 to $1,000,000.

The Camden Iron Works, Camden, N. J., is reported considering the construction of extensions to its plant for shipbuilding work.

The Jahncke Shipbuilding Company, New Orleans, La., Ernest L. Jahncke, president, will build an 8,000-foot drydock for Government work, in accordance with an agreement recently made.

The Maritime Engineering Corporation has been incorporated, with a capital stock of $1,250,000. The company plans to build a steel shipyard at Elizabeth City, N. C.

The Société Normande de Constructions Navales, with offices at 16, Boulevard Malesherbes, Paris, France, has been organized, and is planning the construction of several drydocks. The capital stock is 20,000,000 francs.



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Ships Loading with Coffee for the Allies at a Brazilian Port

SHIPBUILDING CONTRACTS

Orders Booked for the Construction of New Ships

The annual naval appropriation bill just reported by Congress carries $1,325,000,000, and provides for the resumption of construction on the three-year naval programme of battleships, scout cruisers and auxiliaries.

Twohy Bros. Company, Portland, Ore., have received a contract from the United States Shipping Board for the construction of ten steel vessels of about 8,000 tons each. These ships will be built in the yard of the Erickson Engineering Works, in which Twohy Bros. and O. D. Colvin, of Seattle, acquired a half interest.

The Standard Shipbuilding Company, Dominion building, Vancouver, B. C., has received a contract from the Imperial Shipping Board to build ten composite steamers and will establish a plant at Ruskin, B. C.

The Newport News Shipbuilding & Dry Dock Company, Newport News, Va., H. L. Ferguson, president and general manager, is reported to be building thirty destroyers for the United States navy.

The McDougall-Duluth Company, Duluth, Minn., A. Miller McDougall, general manager, has received a contract from the United States Shipping Board to build ten steel steamships.

The Bethlehem Shipbuilding Corporation, South Bethlehem, Pa., J. W. Powell, vice-president, in charge of construction, has received a contract from the United States Shipping Board to build ten towboats. These will be built at the company's Elizabeth, N. J., plant.

The Crowninshield Shipbuilding Company, Fall River, Mass., will build six towboats for the United States Shipping Board.

The Johnson Iron Works, New Orleans, La., Warren Johnson, general manager, will build six towboats for the United States Shipping Board.

The Newburgh Shipyards, Inc., Newburgh, N. Y., unlike other shipyards building fabricated ships for the United States Shipping Board, is a private enterprise. This company has a contract to build ten fabricated steel steamships and has laid the keel of the first.

Whitney Brothers Construction Company, Superior, Wis., are building four steel tugs.

Pushee Brothers, Dennysville, Me., are building two four-masted schooners.

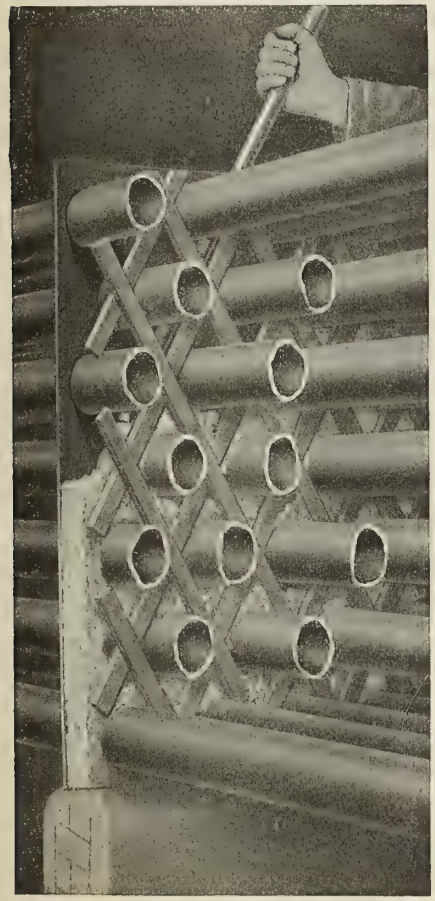
The Wallace Shipyards, Vancouver, B. C., will soon begin work on a 4,350-ton ship.

Boiler Baffles of Plastic Material

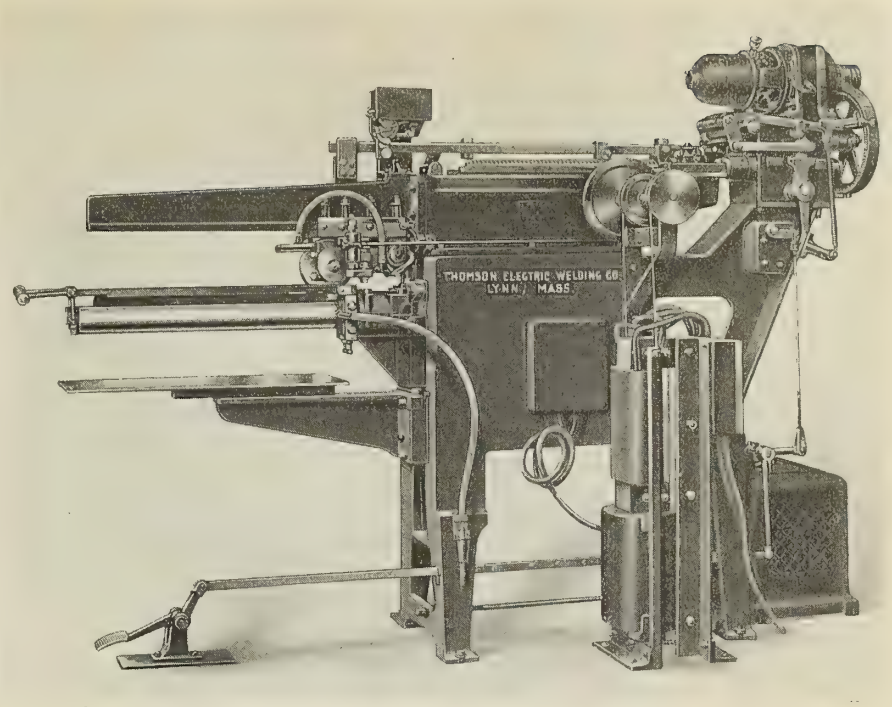
As a substitute for baffles for watertube boilers, consisting of tile, bricks or blocks of refractory material fitted in between the tubes, the Betson Plastic Fire Brick Company, Rome, N. Y., has developed a composition of refractory materials which is shipped in barrels in a moist, plastic condition ready for use. It is pointed out that with this new material it is possible to secure jointless and gas-tight baffles, since the coefficient of expansion is so small that expansion and contraction resulting from variation in the temperature are practically eliminated. Where this material is used, it is emphasized, there is no restriction upon the shape or size of the baffle and any form desired can therefore be secured.

In forming a cross baffle for a watertube boiler of the Babcock & Wilcox type; for example, the cast iron baffle plate is employed as one side of the mold, while the other is formed by thrusting slats into the diagonals between the tubes as illustrated. The plastic material is then poked down through the diagonals to fill the space between the baffle plate and the slats, it being pointed out that it is sufficiently plastic so that it can be forced out around the tubes and fit them snugly. After the work has been done, the boiler is fired up slowly, the slats being burned out and the plastic material dried and vitrified in place. It is pointed out that this operation occupies only a few hours, after which the full load may be put upon the boiler, and inasmuch as the boiler is operated under full steam pressure before the material is thoroughly set, the expansion of the metal forces the soft material away to the position which it should occupy when the boiler is hot, thus insuring a tight fit between the baffle and the tubes when the boiler is under steam. In forming a longitudinal baffle, blocks of wood are placed between the tubes, above and below the space which it is desired that the baffle should occupy. In this way the plastic material, which is shoved in from the sides or the top or bottom of the tube bank, is confined in place.

Other uses of the material are as a substitute for special forms of bricks or blocks, as, for example, where the front headers of horizontal watertube boilers rest upon the front arch, and for lining furnace and combustion chambers, including the front and rear arches, side and bridge walls, etc.



Method of Forming Cross Baffle of Plastic Material in Watertube Boiler



Thomson Electric Welding Machine

Electric Seam Welding Machine

A line of machines for welding seams in sheet iron and steel by the electric resistance process has been developed by the Thomson Electric Welding Company, Lynn, Mass. It consists of two distinct types, the one that is illustrated being driven through a motor, toothed clutch and worm, while the other is supplied with a speed reducer and crank mechanism. Both machines are equipped with traveling upper dies, while practically any form of lower die and jig necessary for handling any variety of can, cylinder or cone can be supplied.

The machine illustrated is intended primarily for welding the longitudinal seams on pieces such as cans, stove parts, flat pieces and rectangular shapes, such as metal boxes where the material does not exceed No. 16 gage in thickness and the length of the seam is not more than 24 inches. The limits between which work can be handled range from 3½ to 20 inches in diameter and 8 to 24 inches in length. In operation, the piece to be welded is secured in a specially designed jig on the lower horn or arbor and pressure applied to the treadle. This engages the clutch of the driving mechanism, and causes the welding roller on the upper horn, which is actuated by the movement of a screw, to come forward. The current is automatically turned on when the welding roller makes contact with the stock and passes through the material to be welded to the lower copper horn, and thence to the transformer, thus completing the circuit. The resistance of the metal being welded is relied upon to generate a welding heat so that the pressure caused by the roller gives a continuous weld for the entire length of the seam. The current is automatically turned off when the roller reaches the end of the seam and the roller is returned to its original position, thus permitting the welded piece to be removed from the jig and replaced by another.

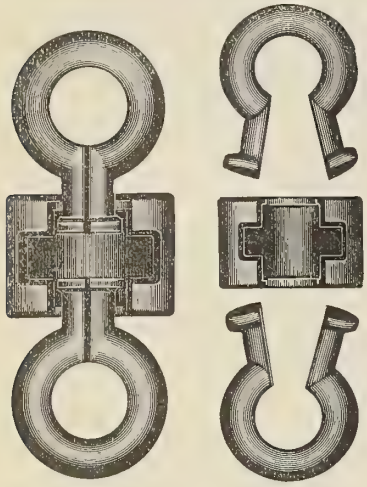
The machine is equipped with an adjustable-speed motor which provides a range equivalent to from 7 to 13 strokes every minute. An hourly output of as high as 200 24-inch welds has been obtained, and where the seam is not so long this figure can be increased, depending upon the character, thickness and shape of the stock and the speed of the operator.

The other machine operates in exactly the same way, and is designed for small sheet metal pieces, such as cans, stove

burners, flat pieces, match boxes and revolver magazines, where the length of the seam does not exceed 8 inches. As high an hourly output as 700 welds has been secured from one of these machines, but this figure is governed by the character, thickness and shape of the stock, the speed of the operator and the number of jigs that can be loaded by the helper.

One Minute for Chain Repairs

A combined swivel and chain repair link (patented) is the unique invention recently placed on the market by the Cleveland Galvanizing Works Company, Cleveland, Ohio. Although it has been on the market but a short time, the One-Minute Swivel Repair Link, as it is called, has found considerable favor among chain users because of its versatility, strength and simplicity, being constructed of but three parts, which can be put in place in the chain with a hammer, pair of pliers or a vise. It may be used with welded, weldless or flat link chain, and is furnished in three sizes for use with the different sizes of chain. An interesting folder has been issued, describing and illustrating the repair link, copy of which can be had by writing the manufacturer.



Combined Swivel and Chain Repair Link

(Photograph copyright by Press Illustrating Service, Inc., New York)

Three-Masted Wooden Schooner Recently Launched at Harrington, Me.

Twenty-One Shipbuilding Companies Chartered in Mississippi Last Year

The following twenty-one companies have been chartered in the State of Mississippi during the past year:

Gulfport Shipbuilding Company, $50,000; International Shipbuilding Company, $50,000; City of Pensacola Ship Company, $150,000; City of Houston Ship Company, $200,000; Gulfport Shipbuilding and Manufacturing Company, $5,000; City of Gulfport Shipbuilding Company, $200,0000; Biloxi Shipyard and Box Factory, $10,000; City of Beaumont Ship Company, $200,000; City of Mobile Ship Company, $200,000; City of Dallas Ship Company, $200,000; Dierkes-Blodgett Shipbuilding Company, $150,000; Arrow Boat Company, $25,000.

International Shipbuilding Company, capital increased from $50,000 to $200,000; Mississippi Shipbuilding Company, $100,000; Hodge Ship Company, $200,000; Coast Ship Company, $100,000; City of Galveston Ship Company, $200,000; City of Lafayette Ship Company, $200,000; City of Orleans Ship Company, $200,000; City of Austin Ship Company, $200,000; City of Waco Ship Company, $200,000.

(Photograph copyright by Press Illustrating Service, Inc., New York)

Wooden Ships in Frame at Harrington, Me.

Evening Course in Ship Drafting and Ship Calculation Given at Pratt Institute

A new course of instruction, especially arranged to serve the present national need for increased productive efficiency in ship and boat building is being given at the Pratt Institute, Brooklyn, N. Y.

The instruction is planned to aid ship draftsmen of limited experience to extend and broaden their practical ability as draftsmen and designers in the great shipbuiling industry now rapidly developing in this country. It is also adapted to the needs of mechanical and structural draftsmen who are transferring to ship drafting. Ship fitters, riggers and others requiring for efficiency in their occupation a practical familiarity with details of ship construction will find this course helpful.

More experienced ship draftsmen may obtain in the advanced term of this course instruction suited to their requirements.

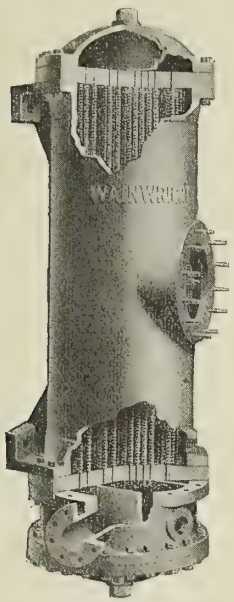
The classes meet three evenings a week, from 7:30 to 9:30 o'clock. A moderate fee, $10.00 for term of twelve weeks, is charged to help meet the cost of instruction. Each student is required to furnish drafting instrument and material for his own use. Application for admission may be made by mail on special forms, which will be sent on request.

Wainwright Marine Feed Water Heater

In the feed heater illustrated, as manufactured by the Alberger Pump and Condenser Company, 140 Cedar street, New York City, the Wainwright corrugated copper tube is used. The general range of the heating is from about 90 to 212 degrees using 5 pounds gage pressure in the heater although

a selection can be made to heat the outgoing feed water to a temperature of about 222 degrees with 5 pounds back pressure (with steam temperature of 227 degrees). With higher back pressure, of course, the temperature of the water leaving the heater would be proportionately increased.

It is claimed that the Wainwright corrugated copper tube agitates all particles of the water, throwing them against the hot tube, so that a much higher rate of transmission is secured in a heater of this style than with plain tubes. All tubes are straight, may



Feed Heater Showing Corrugated Copper Tubes

be inspected by moving a bonnet at the end of a heater farthest from the water connections, and the construction permits replacing of tubes with minimum of effort and delay.

As no steel or wrought iron inside the tube heads is used, and as the water comes in contact only with cast iron and copper, it is claimed that corrosion is avoided and, owing to the fact that no floating heads are used, accidents, due to pulsations of the boiler feed pumps, are avoided.

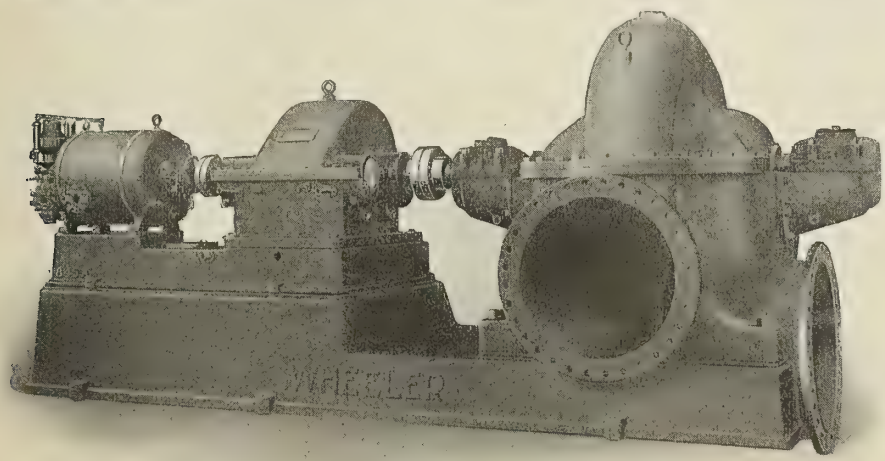
S. S. *Lake Clear* Ready for Launching at Chicago Shipbuilding Company's Yard on February 28

A New End Suction Centrifugal Pump

Here is a new design of pump, manufactured by the Wheeler Condenser & Engineering Company, Carteret, N. J., that is of special interest because of the unusual position of the suction opening. This opening, it will be noted, is directly beneath and parallel to the end bearing. In this position it is out of the way, yet it is in a convenient place for the erection men, for inspection, for upkeep, etc.

This arrangement makes it possible to place a pumping unit in a room of small ground area, considerably smaller than where the suction end is opposite the outlet end. In many cases this also facilitates the making of pipe connections, sometimes saving elbows and reducing the length of piping more or less.

The capacity of the particular pump shown is 45,000 gallons per minute, against a head of 20 feet. The diameter of the outlet pipe is 36 inches. The speed of the pump is 240 revolutions per minute, and is coupled by a 10 to 1 reduction gear to a steam turbine whose speed is 2,400 revolutions per minute.



Centrifugal Pump, with End Suction, Manufactured by Wheeler Condenser & Engineering Company

Quick Work at Lake Yard

That no time is being lost by the Lake shipbuilders in adding tonnage to the American Merchant Marine was shown at the launching of the S. S. *Lake Clear,* at the yards of the Chicago Shipbuilding Company, Chicago, Ill., on February 28. The *Lake Clear* is a full Welland Canal-size vessel, and was launched at 10 A. M. while at 3 P. M. on the same day the launching material had been cleared away and the keel for a new vessel laid on the same berth. Mr. F. C. LaMarche, general superintendent of this yard, states that the credit for this performance belongs to the different department heads and to their men, all of whom co-operated to their utmost.

Many of the standard Welland Canal-size vessels built by this company were originally ordered for foreign account, but the entire capacity of the yard is now being utilized in the effort to produce as many vessels as possible for the Shipping Board.

First Wooden Ship Launched in the East

The Foundation Company of New York had the honor on March 19 of launching the first wooden ship on the Atlantic coast for the Emergency Fleet Corporation. The vessel is a steamship of 3,500 tons deadweight and was christened the *Coyote.* The length is 281 feet 6 inches and the beam 46 feet. A triple expansion reciprocating engine of 1,400 horsepower will give the vessel a speed of 10 knots.

In the construction of this vessel 132,000 feet of timber were used, 715,000 pounds of metal fastenings, 58,000 pounds of steel strapping, 2,800 pounds of oakum and 2,600 pounds of pitch for calking, 6,000 gallons of paint and 4,000 pounds of white lead and oil.

Supply of Ship Timbers for Atlantic Yards Now Adequate

It was recently announced at the New Orleans office of the Emergency Fleet Corporation that every shipyard along the South Atlantic and Gulf coasts is now supplied with all timbers needed to permit of full operations. Many yards are piling up reserve materials. Maximum speed is being rapidly attained in

rushing to completion the first 200 hulls for Uncle Sam's wooden fleet, it was said. Some of these hulls will go into the water this month.

A number of shipyards are planning to operate day and night, as soon as necessary labor is available. Three eight-hour shifts will be maintained.

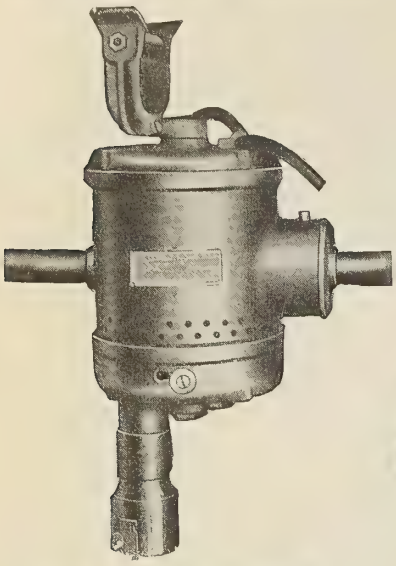


Fig. 1.—Portable Electric Drill

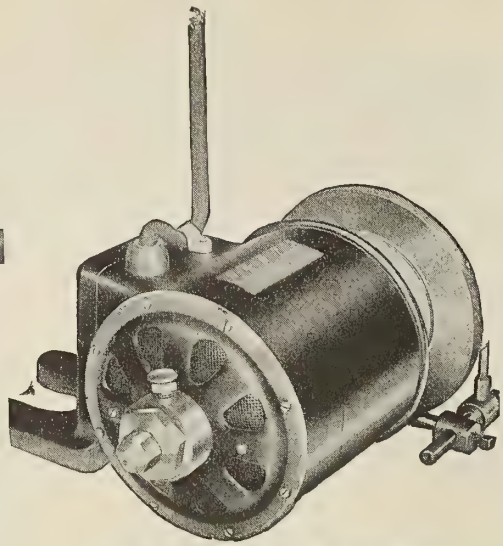


Fig. 2.—Electric Tool Post Grinder

"The situation is very encouraging," said H. D. Foote, assistant director of the Lumber Department of the Fleet Corporation. "Yards are rapidly hitting their stride.

"In spite of great difficulties they have and are still encountering in getting out the big sizes, Southern pine mills are producing ship timbers in increasing volume. No complaints about shortage of materials are now being received from shipyards. We think the work will now proceed rapidly."

Portable Electric Drills and Grinders

At this time, when working in metal and wood are synonymous with carrying on the war, any labor-saving device which can be employed should be put to work at once. Portable electric tools which replace hand operation, save time and labor and increase the output of a given working space. Particularly is this true of a portable electric drill, such as that shown in Fig. 1. Less "elbow room" is required by a workman using one of these devices, and since he can drill a great many more holes per hour, he can replace a number of men who may be given to other tasks. This drill, which is manufactured by Gilfillan Brothers' Smelting and Refining Company, of Los Angeles, Cal., is equipped with gears to give two speeds. These are changed by means of a knob on the bottom of the gear case. The gears themselves are made of chrome nickel steel and run in grease. Ball bearings are used throughout. A ½-inch Standard chuck and a sturdy electric switch are provided. The speed range is 400 revolutions per minute on low speed and 700 revolutions per minute on high speed. Westinghouse motors are furnished.

The same concern also manufactures a tool post grinder adapted for use on lathes. An angle plate can be clamped around the tool post. There is a vertical adjustment of the grinder provided. This grinder is equipped with a Westinghouse ¼-horsepower motor, running at 3,400 revolutions per minute. It is provided with a 6-inch by ⅜-inch grinding wheel, an extension mandrel for internal grinding, fitted with a 1½-inch by ⅜-inch wheel, a tooth rest for cutter grinding and an electric attachment plug with 7½ feet of cord.

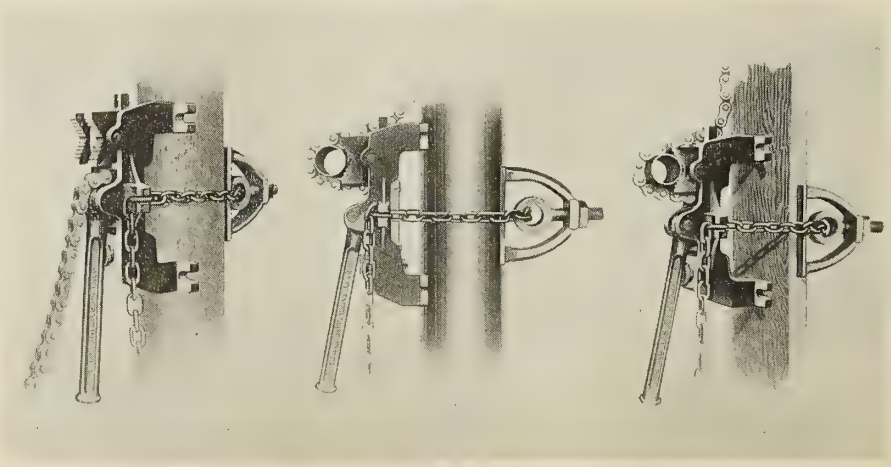
Chaingrip Pipe Vise

The Chaingrip Pipe Vise, manufactured by the Gerolo Manufacturing Company, Old Colony Building, Chicago, is a simple, portable vise, which can be moved from one location and mounted at another in a moment's time. It eliminates long walks to the distant bench vise by always being right at hand. It fastens to any kind of a horizontal or vertical support, whether round, square or flat, without the use of bolts. It locks any size pipe or conduit within its limits by the slight push of a lever. No previous adjustment is necessary. Hence, it saves labor and effort, both by its portability and instantaneous operation.

The base support of the Chaingrip is squared out in the form of an inverted V, at the sides of which are bolt lug feet, to be used only in case the vise is to be permanently bolted in one position. Hence, it will conform to a round, square or flat surface. A clamp support on the opposite side of the column is a part of the Chaingrip equipment. It is a bell section shape, having a boss at the top, through which a threaded supporting eye-bolt passes free. A heavy nut, resting on the top of the boss and engaging the threaded eye-bolt, adjusts the tension of the chain passing through the eye of the eye-bolt. The base of the clamp support is squared out in a manner similar to the vise base, in such a way that it fits the same shaped surfaces.

A heavy wrought-iron chain is riveted on one side of the vise base. It passes around the supporting column, through the eye of the eye-bolt in the clamp support, and thence to the other side of the vise base, a link being held securely in position in a socket. Tightening of the eye-bolt nut tightens the supporting chain and holds the vise vigidly in position.

The Chaingrip Vise locks a pipe or conduit firmly between a double set of steel pipe jaws on one side, and a heavy close linked steel chain on the other. The locking motion is accomplished by the movement of the handle toward the vise. This handle fulcrums on a steel pin, which projects through two bosses, one on either side of the frame of the vise. Directly beneath this fulcrum point the handle takes the shape of a cam, which in turn operates against a movable horizontal bar. To one end of this bar is riveted the steel gripping chain which passes around the pipe or conduit, and locks in a steel socket. The other end, or fulcrum point, of the bar is supported by a threaded bolt, the enlarged, knurled head of which rests upon a boss on the base of the vise. Rotation of the head of the bolt raises or lowers the fulcrum point of the bar, and forms an adjustment of pressure exerted by the other end of the bar on the gripping chain when the handle of the vise is in a locked position—i. e., when it is at the end of its travel toward the vise, and the largest radius of the cam is directly beneath the fulcrum point of the handle support.



Chaingrip Pipe Vise Attached with Ease to Different Types of Supports

TWENTY-THREE NEW VESSELS ESTIMATED OUTPUT FOR MARCH

Fifteen Steel Ships, Aggregating 114,100 Tons, Delivered During February

The United States Shipping Board has made public the following:

Fifteen steel vessels, aggregating 114,100 tons, were completed and delivered in American shipyards in February for the Emergency Fleet Corporation. It is expected that in March the total number will be increased to 23 vessels, of an aggregate tonnage of 188,275.

Some of the ships included in the March schedule already have been completed.

The following table shows the February record of vessels completed and delivered:

Description	Tonnage	Date of Completion
Cargo vessel	8,800	Feb. 12
Do.	8,800	Feb. 4
Do.	9,400	Feb. 4
Do.	8,800	Feb. 4
Do.	10,000	Feb. 3
Do.	6,000	Feb. 6
Tanker	14,900	Feb. 14
Collier	8,600	Feb. 15
Cargo vessel	8,800	Feb. 22
Do.	8,800	Feb. 26
Do.	8,800	Feb. 16
Do.	3,100	Feb. 14
Do.	3,100	Feb. 14
Do.	3,100	Feb. 25
Do.	3,100	Feb. 27
Total	114,100	

Estimated Deliveries for March

The estimated deliveries for March are shown in the following table:

Description	Tonnage	Date of Completion
Tanker*	10,475	Feb. 28
Cargo vessel	8,800	Mar. 4
Do.	3,300	Mar. 6
Do.	4,500	Mar. 1
Do.	7,500	Mar. 1
Tanker	7,000	Mar. 7
Do.	10,475	Mar. 4
Cargo vessel	8,800	Mar. 9
Do.	7,500	Mar. 10
Do.	6,200	Mar. 11
Tanker	12,650	Mar. 15
Cargo vessel	8,800	Mar. 15
Collier	8,600	Mar. 15
Tanker	10,300	Mar. 15
Cargo vessel	8,800	Mar. 15
Do.	8,800	Mar. 17
Collier	4,900	Mar. 20
Cargo vessel	10,500	Mar. 25
Do.	3,300	Mar. 25
Tanker	9,000	Mar. 27
Cargo vessel	8,800	Mar. 30
Do.	8,800	Mar. 30
Tanker	10,475	Mar. 31
Total	188,275	

* Accepted March 1.

Year's Growth in Number of Shipyard Workers

With the advent of the volunteer workers, the United States will have about 450,000 skilled men actually at work in shipyards. That shows what can be done in a little over a year's time. The following figures speak for themselves. In 1916 the wage-earners in steel shipyards of the country numbered:

Steel shipyards	43,582
Wood shipyards	1,380
Total	44,962

On January 1, 1918, the workers numbered:

Steel shipyards	181,273
Wood shipyards	23,437
Total	204,710

Add the 250,000 shipyard volunteers and the grand total is 454,710 shipbuilders.

PERSONAL

Frederick Holbrook, of Holbrook, Cabot & Rollins, Inc., engineers, has been placed in charge of the Hog Island shipyard as managing director and president of the American International Shipbuilding Corporation, succeeding Dwight T. Robinson, resigned.

D. H. Cox, of Cox & Stevens, naval architects, New York, has been appointed manager of the division of steel ship construction, United States Shipping Board Emergency Fleet Corporation, succeeding Rear Admiral F. T. Bowles, who has been appointed assistant general manager of the Emergency Fleet Corporation.

L. T. Bush resigned as chief executive officer of the War Board for the port of New York on February 19. Mr. Bush holds the appointment of Chief of Embarkation of the Port of New York and Director of Harbor and Terminal Facilities.

A. C. Voorhees, chief submarine draftsman of the California Shipbuilding Company, Long Beach, Cal., has been appointed assistant to the general superintendent of the Schaw-Batcher Company Pipe Works, Burlingame, Cal., which has contracts for eighteen freighters for the Emergency Fleet Corporation.

A. Cyril Rimmer, formerly assistant to the president of the Samuel L. Moore & Sons Corporation, Elizabeth, N. J., has been appointed assistant to the vice-president and general manager of the Federal Shipbuilding Company, New York.

Loyall A. Osborne, of New York, vice-president of the Westinghouse Electric & Manufacturing Company, and chairman of the executive committee of the National Industrial Conference Board, has been appointed by the Secretary of Labor a member of a committee on industrial peace during the war.

W. H. Thompson, for many years prominent in the heavy electric traction work in the Westinghouse Electric & Manufacturing Company, has resigned to accept the position of works manager of the Fairmont Mining Machinery Company, Fairmont, W. Va., makers of coal mining equipment.

William T. Price has recently resigned as manager and chief engineer of the De La Vergne Machine Company to become president of the P-R Engine Company, of New York, and second vice-president of the Rathbun-Jones Engineering Company, of Toledo, which will undertake the sale and manufacture, respectively, of Price-Rathbun stationary and marine oil engines, built in accordance with the new principle of fuel injection developed by Mr. Price during the past several years. The P-R Engine Company has its main office at 110 West Fortieth street, New York, and other offices at Philadelphia, Baltimore and Toledo.

William Alexander has been appointed superintendent of the Groton Iron Works, Groton, Conn., succeeding Thomas Spence. George K. Warner has been appointed superintendent of machinery and William H. Godfrey superintendent of woodwork at the same yard.

OBITUARY

Frank J. Hurley, of the Independent Pneumatic Tool Company, died at his home in East Orange, N. J., on March 10, aged 29.

George Von L. Meyer, former Secretary of the Navy, died at his home in Boston on March 9 after an illness of several weeks, aged 60. Mr. Meyer was ambassador to Italy from 1900 to 1905, and ambassador to Russia from 1905 to 1907. He was Postmaster-General under President Roosevelt, and Secretary of the Navy under both Roosevelt and Taft administrations.

Lord Brassey, former Civil Lord of the British Admiralty and founder and first editor of the *Naval Annual*, died in London on February 23 aged 82. Lord Brassey was a former president of the Institution of Naval Architects and member of Parliament. From 1895 to 1900 he was Governor of Victoria. He was an honorary associate member of the Society of Naval Architects and Marine Engineers.

Col. Edwin Augustus Stevens, Goverment-Inspector of Shipyards, and honorary vice-president of the Society of Naval Architects and Marine Engineers, died on March 8 in Washington, D. C., aged 60. Colonel Stevens was the second son of Edwin Augustus Stevens, founder of the Stevens Institute of Technology, Hoboken, N. J. He was educated at St. Paul's School, Concord, N. H., and Princeton University, afterward receiving a degree in engineering at Stevens Institute of Technology. Colonel Stevens designed the first screw ferryboat, the *Bergen*, which is still in service on the Hudson River. He was consulting engineer for the city of New York in connection with the construction of ferryboats for the municipal ferry to Staten Island, and also had charge of the designs of ferryboats for the Lackawanna Railroad. For years he was president of the Hoboken Ferry Company. In 1911, Woodrow Wilson, then Governor of New Jersey, appointed Colonel Stevens State Public Road Commissioner. More recently he was made a member of the State Highway Commission, and after the entrance of the United States into the European war President Wilson appointed him Government-Inspector of Shipyards. Colonel Stevens was a life member and vice-president of the American Society of Mechanical Engineers, and honorary vice-president and life member of the Society of Naval Architects and Marine Engineers. He was also a member of the American Society of Civil Engineers and the Institution of Naval Architects.

Commodore Jacob W. Miller, U. S. N., retired, organizer of the State Naval Militia, and member of the Board of Governors of the New York State Nautical School, died suddenly of pneumonia at his home in New York on March 8, aged 70. Commodore Miller served in the United States Navy from 1867 to 1884. After resigning from the navy he became an officer in the Nicaragua Canal Company. Later he became manager of the Providence & Stonington Steamship Company, and afterwards manager of the combined Sound Steamship Lines and vice-president of the New York, New Haven & Hartford Railroad. When the Cape Cod Canal Company was formed he was elected vice-president and manager of that corporation.

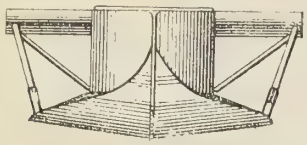
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by George A. Hutchinson, Esq., registered patent attorney, Washington Loan and Trust Building, Washington, D. C.

1,223,319. FLYING-BOAT HULL. GLENN H. CURTISS, OF BUFFALO, N. Y., ASSIGNOR TO CURTISS AEROPLANE AND MOTOR CORPORATION, A CORPORATION OF NEW YORK.

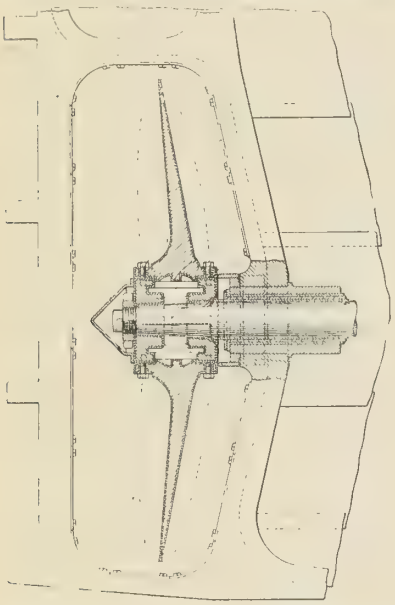
Claim 1.—In a hull for flying boats, a hydroplaning bottom, and fin excrescences formed by



extending the bottom planking laterally beyond the chines of the boat body proper. Twenty-two claims.

1,216,549. SHIP PROPELLER. MATTHEWS E. DAVIS, OF NEW YORK, N. Y.

Claim 1.—The combination of an iron or steel hull, with a steel propeller shaft having a fixed sleeve insulated from the hull; a propeller shaft having a fixed sleeve insulated from the hull; a propeller keyed to and also clamped endwise in place on the shaft; and a gasket between the opposed walls of the sleeve and propeller hub; the propeller comprising an iron or steel



propeller-shaped core and a copper-containing metal coating on its surfaces, and the hull being provided with removable zinc plates adjacent the propeller; the copper-containing metal coating resisting pitting and preventing pitting of the coated propeller core and of the portion of the shaft in the propeller hub bore; and the zinc plates in proximity to the propeller protecting the hull against electrolytic action; and the gasket excluding water from access to the shaft at the joint between the opposed walls of said sleeve and propeller hub; and the said metallic coating increasing the strength of the blades cross-sectionally.

1,209,640. HYDROPLANE-BOAT. CLINTON H. CRANE, OF HEWLETT, N. Y., ASSIGNOR TO J. FREDERIC TAMS AND CHARLES KING, DOING BUSINESS UNDER THE FIRM NAME OF TAMS, LEMOINE & CRANE, OF NEW YORK, N. Y.

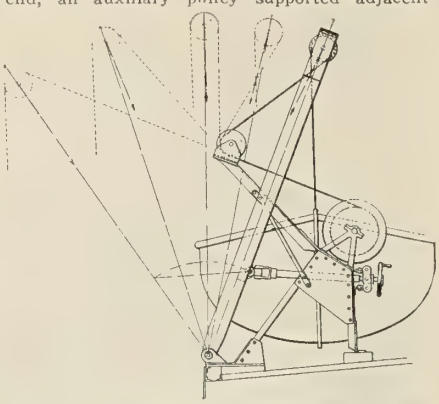
Claim 1.—A hydroplane boat provided with a fixed forward plane member, a wholly submerged after plane member secured to the propeller struts, and rigidly set at a predetermined angle in conjunction with the angle of the forward plane member, a second after plane member directly superimposed above, and of larger area than, said submerged plane member secured to the propeller struts and rudder post, and adapted to rise to, or above, the surface of the water as the speed of the boat increases, and a rudder mounted between said after plane members. Four claims.

1,240,538. APPARATUS FOR RAISING SUNKEN VESSELS. RICHARD M. BROWNE, AND THOMAS D. SCOTT, OF NEW YORK, N. Y.

Claim 1.—A pontoon having a flat side arranged to lie snugly against the side of a vessel, and having a co-extensive flange whereby said pontoon may be bolted to the vessel. Seven claims.

1,246,778. DAVIT. HAROLD F. NORTON, OF NEWPORT NEWS, VA.

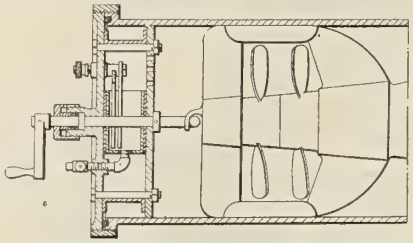
Claim 1.—In an apparatus for transferring a load, the combination of a beam pivotally supported at its lower end, a pulley at its upper end, an auxiliary pulley supported adjacent



the beam independently thereof and a rope passing over the two pulleys, the second pulley being so positioned that the direction of the resultant force acting on the beam lies substantially along the beam for all positions of the beam during the transfer of the load. Thirteen claims.

1,247,417. BREECH FOR TORPEDO TUBES. ONIS MARCUS LEONARD, OF MACY, IND.

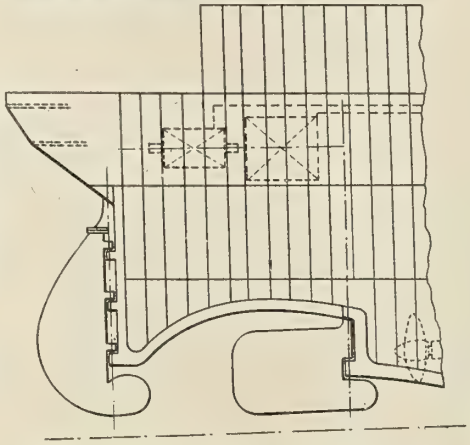
Claim 1.—A device including a torpedo tube provided with a breech and having an evaporating receptacle adapted to be supplied with a



gas forming liquid, and means for supplying heat to the receptacle for converting the liquid into gas of the desired pressure. Eight claims.

1,247,448. ARRANGEMENT OF SHIP RUDDERS. GUIDO PO, OF ROME, ITALY.

Claim 1.—A ship provided with two rudders placed one behind the other in the middle longitudinal plane, the area of and the dis-



tance between the rudders being such as to develop equal and opposite turning moments when set over by equal angles in opposite directions. Two claims.

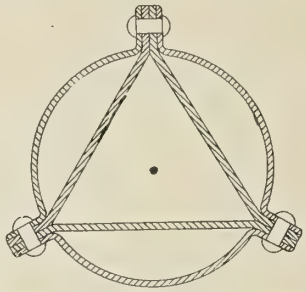
1,223,154. METHOD OF RENDERING SHIPS UNSINKABLE. WILLIAM T. DONNELLY, OF BROOKLYN, N. Y.

Claim 1.—The method of loading ships, which consists in confining to such an extent only that it will float in water and will afford its between decks watertight container and loading container with cargo portion of the buoyancy required to maintain the ship afloat when water logged. Two claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

108,525. "THE IMPROVED METHOD OF CONSTRUCTING IRON AND STEEL MASTS, DERRICKS, DERRICK POSTS, PILLARS, TUBING AND THE LIKE." T. W. SIDGWICK, OF MIDDLESBOROUGH-ON-TEES.

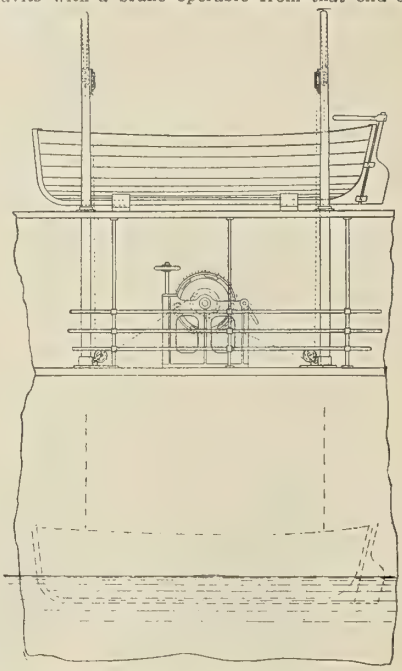
The tubular structure consists of three sectional parts formed of steel plates pressed or



rolled to the required curved form. These parts are formed with radial longitudinal flanges at the edges, and between them are disposed longitudinal plates formed with flanges which are clamped between the flanges by rivets so that a longitudinal inner strengthening core of triangular section is formed within the outer tubular shell or casing and extending for the whole or any desired part of its length. The plates thus built up may be in one length to form the complete article, say, for example, a mast or derrick or two or more such structures may be placed end on end and fastened together in any appropriate way.

109,699. "IMPROVEMENTS IN AND CONNECTED WITH MECHANISM FOR RAISING AND LOWERING SHIPS' BOATS AND THE LIKE." P. J. SMITH, OF HARROW, AND T. BREDENBERG, OF EALING.

The adaptation to slewing davits of an arrangement comprising a winch or the like located between the davits or alongside one of the davits with a brake operable from that end of



the winch or the like adjacent the ship's side. The boat is lowered on an even keel, it being impossible to lower one end at a faster rate than the other. The boat can be lowered in safety even when the ship is traveling at a moderate speed through the water. The mechanism can be fitted to existing davits at a very low cost. Lowering being speedy and in complete control of one man, who watches the descent, the risk of the boat fouling the ship's side and being damaged is greatly lessened. For heavy lifeboats the falls may be passed around a block adapted to be hooked to the boat and the free end attached to davit head, thus halving the strain on the falls.